THE CASTLE OF KNOWLEDGE.

To Knowledge is this Castle set,
All Learnings friends wil it support,
So shall their name great honour get,
And gaine great fame with good report.

3

Though spitefull Fortune turn'd hor wheele,
To stay the Sphere of Vranie,
Yet doth the sphere resist that wheele,
And flee'th all Fortunes villanie.
Though earth do honour Fortunes ball,
And beetles blinde her wheele aduance,
The heauens to Fortune are not thrall,
The spheres surmount all Fortunes chance.

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KNOWLEDGE
IS
LIFE

TO THE MOST MIGHTIE AND MOST PVISSANT PRINCESSE MARIE, BY THE GRACE OF GOD QVEENE of England, Spaine, both Sicils, France, Ieruſalem, and Ireland: Defender of the Faith: *Archdutcheſſe of Auſtria: Dutcheſſe of Millaine, Burgundie, and Brabant: Counteſſe of Haſpurge, Flanders, Tyroll, &c.*

AS loue of learning and zeale vnto Knowledge (moſt dread Soueraigne Lady) diſprouoke me to attempt an enterpriſe far aboue mine abilitie that is, to build a Caſtle for Knowledge to reſt in, after her long baniſhment & tedious exile: Although I could not be permitted by diſturbance of cruell Fortune, to accompliſh now my building as I had drawn the plot: yet in deſpite of Fortune, thus much haue I done, which is more then euer was done in this tongue before, as farre as I can heare. But conſidering by miſfortune this Fort lacketh fence, and needeth ſome good gouernour to ſupply that that wanteth, that Knowledge may reſt vnder ſafe protection, I thought it my duety to make moſt humble ſute vnto your excellent Maieſty, that it might pleaſe your Highnes to accept this poore Caſtle into your gracious tuition: that not only in time of your Maieſties raigne, but by your Highneſſe ſpeciall defence, Knowledge might be maintained and reuoked from exile. Vnto which ſute I am the more boldened, through remembrance how God in deſpite of cancred malice, and of frowning Fortune, did exalt your Maieſtie to that throne royall which of iuſtice did belong vnto your Highnes, although the muſers of miſchiefe wrought much to the contrary. In which matter, as Knowledge did detect the malice of other,

and taught your true subiects their duty to their Souereigne, so Knowledge yet diuers wayes shall further your Maiesty. And therfore am I incouraged to sue to your Royall Excellency, not only to take into your Highnes protection this Castle of Knowledge, but all Knowledges friends, which in hir maintenance do keep continuall warre against pestilent Ignorance, the subuerter of Realmes: which knoweth no virtue, honesty, nor duety, and therefore meaneth no truth, howsoeuer she flatter: yet doth she oftentimes shew great countenaunce of friendship, when she meaneth nothing lesse. Heere could I paint forth Ignorance in hir right colours, but vnto your Maiestie it is needlesse, whom God not only hath indewed with excellent knowledge, but also hath ayded with such prudent Councellours, that it may seeme arrogancy in any such as I am, to make explication, or in manner more then only insinuation of any doubtfull matters. It may therefore please your Maiestie, for loue vnto Knowledge, and fauour to your Highnesse subiects, to accept this simple Castle into your Graces defence, and so shall I be animated to finish the rest, and to publish it vnder your Maiesties name, whom God of his mercy increase in all honour royall, and true felicitie, and continue prosperously and long amongst vs, Amen.

Your Maiesties most humble subiect,

Robert Record Physicion.

THE PREFACE TO THE READER.

IF Reaſons reach tranſcend the Skie,
Why ſhould it then to earth be bound?
The wit is wronged and led awrie,
If mind be married to the ground.

THEREFORE,

WHen *Scipio* behelde out of the high Heauens the ſmalneſſe of the earth with the kingdomes in it, he could no leſſe but eſteeme the trauell of men moſt vaine, which ſuſtaine ſo much griefe with infinite dangers to get ſo ſmall a corner of that little ball; ſo that it irked him (as he then declared) to conſider the ſmallneſſe of that their kingdome, which men ſo much did magnifie. Whoſoeuer therefore (by *Scipioes* good admoniſhment) doth mind to auoyd the name of vanitie, and wiſh to attaine the name of a man, let him contemne thoſe trifling triumphs, and little eſteeme that little lump of clay: but rather look vpward to the heauens, as nature hath taught him, and not like a beaſt goe poring on the ground, and like a ſcathen ſwine runne rooting in the earth. Yea, let him thinke (as *Plato* with diuers other Philoſophers did truely affirme) that for this intent were eies giuen vnto men, that they might with them behold the heauens, which is the Theatre of Gods mighty power, and the chiefe ſpectacle of all his diuine workes. There are thoſe viſible creatures of God, by which many wiſe philoſophers attained to the knowledge of his inuiſible power. There are thoſe ſtrange conſtellations, by which *Iob* doth prooue the mighty maieſtie & omnipotencie of god. There are thoſe pure creatures, which waxe not weary with labour, neither grow old by continuance, but are as freſh now in beauty and ſhape, as the firſt day of their creation: and as apt now to performe their courſe, as they were the firſt houre that they began. And though time wholly depend of it, yet time cannot

vtter any force in it : yea though all other things in the worlde by time be consumed, and euen the most hard mettalles fretted into drosse, yet the liquide heauens not onely gouerne Time it selfe, but vtterly stand cleere from all corruption of Time. Oh worthy temple of Gods magnificence. Oh throne of glory and seate of the Lord : thy substance most pure what tongue can describe? thy beauty with starres so garnished and glittering: thy motions so maruellous, thine influence strange, thy tokens so terrible, to stonish mens hearts : thy signes are so wonderous, surmounting mans wit, the effectes of thy motions so diuers in kinde : so hard for to search, and worse for to find. Thy greatnes so huge, thy compasse so large, thy rolling so swift, and yet seemeth slowe: thy stay so vnknowen, thy place without name : thy spheres are meere wonders, & so is thy frame. Thy lights are so liking to comfort mens mindes, no beast is so brutish, but that he still findes, thy warmenesse to worke him great solace and ease : thy colour to comfort his sight & his braine. Thy stars in such order, thy circles so fine : thy platforme is painted with many a signe. Oh maruelous Maker, oh God of good gouernance : thy works are all wonderous, thy cunning vnknowen : yet seedes of all knowledge in that booke are sowen. The signes of the times who can them comprise? the tokens of troubles what man could deuise? And yet in that booke who rightly can reade, to all secret knowledge it will him strait leade. The starre in the East did gouerne the Wisemen, and taught them the very region where Christ should be borne. And further, by it they vnderstoode, that hee was the true King of Iewes, and Sauiour of Israel. And though many saw the starre as well as they, yet fewe or none knew the signification but they : yet did God at the beginning ordaine the stars to be as signes and tokens of Times alteration: and namely of such straunge effectes as seldome come in vre, and therefore are knowen but to few men. These woorkes the more straunge they bee, the more ought men to esteeme the fruite of them : to magnifie the knowledge of them, and to study to vnderstand the meane to attaine them, but most of all to honour, praise and glorifie the Author of them, who willeth nothing to happen so sodainely on the most wicked, but by some signes and tokens hee giueth warning of them : of which thing whosoeuer standeth in doubt, let him peruse the state of times, and hee shal see wonderous things. Before the floud of *Noah* although God by special reuelation vttered his mind to his seruant *Noah*, yet did he also by wonderful signes & strange coniunctions, expres the same to the whole world: for al the planets were in coniunction in watery signes: so that no nation might excuse themselues, for that they were so farre distant from *Noah*, that they could not heare his preaching, sith all nations might see

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the heauens, & the tokens in it, although but few in euery nation could skill of them. And though *Noah* could not in perſon go into al partes of the world, yet was that office ſupplied by the heauens, of whoſe reuolutions it is written by *Dauid*: They haue no ſpeach nor language, ſo that their voice cannot be heard. Yet did their courſe extend into all the earth, and their wordes into the extreame boundes of the world. So was there neuer any great chaunge in the worlde, neither tranſlations of Empires, neither ſcarſe any fall of famous princes, no dearth and penurie, no death and mortalitie, but God by the ſignes of heauen did premoniſh men thereof, to repent and beware betime, if they had any grace. The examples are infinite, and all hiſtories ſo full of them, that I think it needleſſe to make any rehearſal of thē now: eſpecially ſeeing they appertaine to the Iudicial part of Aſtronomy, rather then to this part of the motions; yet ſhal it not be preiudiciall any waies, to repeate an example or two. As namely before the building of Rome, there was a verie notable eclipſe of the ſun, declaring that the libertie of the worlde began then to decay, when Rome began to riſe, which ſhould ſubdue al the world neere-hand: as in effect afterward it did ſucceede, increaſing ſtill by little and little, and continuing for a long time, till the *Gothes* in the time of *Arcadius* and *Honorius*, did ſpoile that citie, and ſubdue their power. At which time alſo ſtrange ſignes did appeare in the aire, and in the skie: Which ſeemed not only to ſignifie the deuaſtation of the Empire of Rome, but alſo the ſubduing of al the Weſt prouinces, by ſtrange inuaſion of barbarous nations. Many other ſtrange eclipſes both of ſun and moone, beſide the appearing of ſundry ſunnes, and ſtrange ſhapes of the moone, and the ſtarres diuerſly diſordered, with Rainbowes of maruellous formes, Cometes of diuers kindes, and other wonderfull ſignes, which euer were meſſengers of as wonderfull effectes, of newe innouations, ſtrange tranſmutations, and ſometime vtter ſubuerſions, not only of ſmall prouinces, but alſo of great kingdomes, yea and of manie Regions at once. And therefore ſaith *M. Manilius*,

Nunquam futilibus excanduit ignibus æther.
The earth doth euer feele griefe and teene,
When thoſe ſtrange ſightes in heauen be ſeen.

But who ſo can skill of their natures, and coniecture rightly the effect of them and their menacings, ſhalbe able not only to auoid many inconueniences, but alſo to atchieue many vnlikely attempts: and in concluſion be a gouernour and ruler of the ſtars, according to that vulgar ſentence gathered out of *Ptolomy*:

Sapiens dominabitur astris:
The wise by prudence, and good skill,
May rule the starres to serue his will.

I minde not to discourse in declaring the profite and commoditie of Astronomie, but only to admonish briefly the reader, that he may thinke the studie worthie his trauell, and to know it to be the most necessary studie that can be, for any man that desireth perfection of wisedome. What benefite doth come by it to the true knowledge of husbandrie & nauigation, I am assured the very simplest in those artes doe partly perceiue: and the cunningest in the same do so fully vnderstand, that they iudge themselues naked and bare without it, and vtterly destitute of all excellencie in their arte. In phisicke the vse of it is so large in iudging duely of complexions, in prescribing right order of diet and conuersation, in gouernance of health, for iust ministration of medicines in time of sicknes, and in right iudgement of the Criticall daies, that without it, phisicke is to be accompted vtterly imperfect. For proofe whereof, although there be infinite places in *Hippocrates* and *Galen*, & diuers other good writers: yet he that hath read in *Hippocrates* but that one booke of Aire, Water, and Regions, and *Galen* his 3. book of Criticall daies, cannot be ignorant how necessary an instrumēt Astronomy is vnto Phisicke, as both those bookes doe testifie at large. But omitting the testimonies of famous writers (which would make a wonderfull volume of themselues, if they were written only togither) I wil vse a simple plain proofe manifest to al men, and therefore most apt for to perswade all men. First to begin with sowing of graine, with graffing and planting, who is so rude, but knoweth, that without these be duely done, and in their seasonable time, men cannot conueniently liue on the earth? And howe are their times knowne, but by the rising and setting of certaine notable starres? Peraduenture some man will answere, that by the monethes of the yeare all men doe know their times without farther Astronomy. Which answere is such, as if a carpenter or mason should say, that hee can worke with his compasse, ruler, squire, plambe line, and such like instruments, without any knowledge in Geometry: but how ridiculous an answere this were, all men can iudge. Likewise, if a maister of a shippe would say, that he can saile and gouerne his course by his compasse and his card, with his quadrant and his other instrumentes, without anie knowledge in Cosmography or Astronomy, woulde not all men that heare him, deride him, or thinke him mad, for speaking so vndiscrectly, especially such as know (as few are ignorant therein) that all those instrumentes are made by those artes, and appertaine to them? So, if the distinction of times doe depend of Astronomy altogither, and the

monethes

monethes would soone run out of their courses, if the aid that it hath by that arte were neglected: so that Michaelmas day would happen in the spring time, and the Annunciation of our Lady would fall after harueſt (as the trueth is, it would do, if Aſtronomicall account were not.) Who can ſhew himſelfe ſo madde as to deny the neceſſary vſe of Aſtronomy, in due keeping the times of the yeeres? The Eccleſiaſticall hiſtorie doeth declare at large, and other writers in great number doe teſtifie, that great controuerſie hath beene in the Church, for the right obſeruation of Eaſter, which controuerſie could neuer be decided but by the knowledge of Aſtronomy. And of late yeeres, in diuers Counceiles redreſſe hath beene ſought for the iuſt obſeruation of it: conſidering that if errour be in it, all other mooueable Feaſtes are wrongly kept by that occaſion, and Lent diſplaced ſo, that ſometime it hath beene keept ſooner then it ought, and at other times later then it ought: which fault can neuer be redreſſed but by Aſtronomy. Whereby it appeareth alſo manifeſtly, that in eccleſiaſticall matters Aſtronomy hath a great vſe: but that is ſo well knowen, that euery man almoſt doth confeſſe it. And generally, whoſoeuer doeth take benefite by the due diſtinction of the yere, he can not chuſe but acknowledge that the ſame commodity doth come by Aſtronomy. If I ſhould ſpecially and particularly diſcourſe in euery kinde of ſcience and artes, and ſhew how they are aided by Aſtronomy, I ſhoulde make my Preface ouer long, and repeat things that all men do know. In law, for contracts and bargaines the time is moſt neceſſary to be obſerued, but eſpecially, if they depende vpon mooueable feaſtes, wherein Aſtronomy muſt diſcuſſe the doubt. In Grammar, Logike, and Rhetorike, how needfull it is, and in hiſtories alſo, I neede ſay nothing, but remit all men to the reading of thoſe bookes which are vſed in thoſe artes, whreeby it ſhall appeare, that without the principles of Aſtronomy thoſe bookes can not be vnderſtoode. Then for vulgare artes, how the knowledge of ebbes and floudes doeth profit, many men, but ſpecially Mariners can teſtifie, and namely ſuch as vnderſtand what errour commeth by the difference of the true account therein, and the vulgare account. Againe, for lopping of trees, and wood fall, and diuers other obſeruations in husbandry, the conſideration of the Sunne, and commonly of the Moone, doeth greatly helpe. Wherefore I may conclude, that in all artes and ſciences, in Law, Phyſicke, and Diuinitie, in Mariners arte and husbandrie, the profit of Aſtronomie is exceeding neceſſary. But aboue all other things, the teſtimony of Chriſt in the Scripture doeth moſt approoue it, when hee doth declare, that ſignes of his comming, and of other ſtrange effects ſhall be ſeene in the Sunne, Moone and Starres. Alſo for alteration of weather he teſtified,

that

that many did marke the face of heauen, and pronounced truely of the weather, and therefore blameth them that they could not marke and iudge the signes of the comming of the sonne of man. But here possibly some men will obiect the saying of the Prophet: *Feare not the signes of heauen.* Whereunto I may duely answere: that those wordes of *Hieremie* doe forbid honouring of them as Gods, as the text is plaine. For oftentimes in the scriptures, feare of God is taken for honour of God, and so is it here. Else otherwise might I answere that the true seruants of God which haue reposed the loue and feare of God in their hearts, are neuer afraid of any tokens that God sendeth, but reioyce to see them, and glorifie God for them. But because in this case there bee many diuines that can better declare those things then I, which am a man of another profession, I will remit that matter to them: only admonishing al men, that the sun, the moone, and the starres, were ordained of God to serue all nations that be vnder the heauens, as *Moses* doth testifie. Then, seeing God hath made them for mans commoditie, and to bee distincters of times, and for signes and tokens, for aide of mens knowledge, let not men be vnkinde to God againe, but lift vp their eies to heauen, and behold the good giftes of God, note diligently their maruellous motions, and studiously consider their wonderfull alterations, with perpetuall constancie and inuiolable order: so shall men neuer be doubtful of Gods prouidence toward them, of his dayly prouision for them, when they see hee hath made such an vnexplicable frame to serue only for mans vse, for whose sake al other creatures also were made. In token therfore of thankfulnesse, let vs sing an Hymne vnto that God, praising his name, and magnifying him for euer and euer.

The world is wrought right wonderously,
Whose partes exceedes mens phantasies:
His maker yet most meruailously
Surmounteth more all mens deuise.

No eie hath seene, no eare hath heard
The least sparkes of his Maiestie:
All thoughtes of heartes are fully barde
To comprehend his Deitie.

Oh Lord, who may thy power know?
What minde can reache thee to behold?
In heauen aboue, in earth belowe
His presence is, for so he would.

The Preface.

His goodneſſe great, ſo is his power,
His wiſedome equall with them both:
No want of wil, ſith euerie houre
His grace to ſhew he is not lothe.

Behold his power in the skie,
His wiſedome eche where doth appeare:
His goodneſſe doth grace multiply,
In heauen, in earth, both farre and nere.

FINIS.

An Admonition for the orderly trade of ſtudie in the au-

thors works, appertaining to the Mathematicalles

The ground is thought that ſteady ſtay,
Where no foote faileth that well was pight:
Whereon who walketh by certaine way,
His paſe is like to proſper right.

1 The *Ground of Artes* who hath well tread.
And noted well the ſlippery ſlabbes,
That may him force to ſlide or fall,
He hath a ſtaffe to ſtay withall.

2 Then if he trade that *Pathway* pure
That vnto Knowledge leadeth ſure:
He may be bold t' approch *The Gate*
3 *Of Knowledge* and paſſe in thereat.

Where if with *Meaſure* he do well treate,
4 To *Knowledges Caſtle* he may ſoone get.
There if he trauel and quaint him well,
5 *The Treaſure of Knowledge* is his ech deale.

5 This *Treaſure* though that ſome would haue,
3 Which *Meaſures* friendſhip do not craue,
2 Nor walke the *Path* that leadeth the way,
1 Nor in *Artes ground* haue made their ſtay:
Though bragge they may, and get falſe fame,
4 In *Knowledges* Court they neuer came,

The contentes in briefe of the 4 Treatiſes of *the Caſtle of Knowledge, containing the expli-* cation of the Sphere, both celeſtiall and materiall, and di-

uers other things incident thereto. With ſundry pleaſant proofes and certaine new demonſtrations, not written before in any vulgar works.

The firſt treatiſe is an introduction into the Sphere, declaring the neceſſary partes of it, as well for the materiall Sphere, as for the celeſtiall: And that no partes of it are admitted without profitable vſe.

The ſecond treatiſe doth teach the making of the ſphere, as well in ſound and maſsie forme, as alſo in Ring forme, with hoopes: And the proportions of eche of them iuſtly deſcribed.

The third treatiſe doth briefly declare certaine thinges appertaining to the vſe of the ſphere, and other matters thereunto incident, without proofe or demonſtration: and that briefly, for eaſineſſe in learning and remembring.

The fourth treatiſe doth approoue many thinges, that were noted in other parts before: and beſide them addeth diuers other matters, concerning the neceſſary vſe of the Sphere, which were not touched before: and doth bring demonſtration of other certaine proofes for the perſwading of them: wherein are many tables ſet forth verie pleaſant and profitable.

If ought here want, that you deſire,
Remember where this worke was wrought:
In Plutoes *forge with ſcarſe good fire.*
This ruſtie Sphere to end was brought.
But if I may it file againe,
The ruſt I truſt to ſcoure off cleane.

¶ The first Treatise of the Castle of Know-ledge : *which is an Induction to the neces-*sarie parts of the Sphere, as wel celestiall as materiall.

Scholler.

THe time seemeth long (be it neuer so short indeede) to him that desirously looketh for any thing: for as the obtaining of it bringeth great pleasure, namely the thing it self being profitable, so the want thereof causeth displeasure and continuall griefe till the desire be either fully satisfied, or partly (at the least) accomplished. The desire of knowledge.

Maister.

And sometimes we see, that when the desire is partly performed, and the pleasantnesse of the same once tasted of, the desire thereby nothing asswageth, but contrariwise greatly increaseth: and the more it getteth, the more it desireth; so that in this point may knowledge well be compared to Couetousnes: for as the couetous mind with getting is neuer satisfied, so knowledge, by knowing, doth still couet more: and as it increaseth, so doth it still learne the vilenesse of Ignorance, and profit of Sciences, and therefore cannot rest from searching more knowledge, as long as it spieth any spot of ignorance.

Scholler.

This oftentimes as I haue considered, maketh me to muse what mind is in them, which care for no knowledge, nor esteeme any science.

Maister.

This is the greatest point of all ignorance, not to know the grosseneſſe of ignorance, & not to vnderstand the benefit of knowledge, and with this fault are a great number spotted. The next is their fault, which perceiue sufficiently what vilenesse is in ignorance, and what profit in knowledge, and yet of a certaine negligence partly, and partly for other pleasures, they omit to The grosseneſſe of ignorance.

trauell any whit for knowledge, and content themselues with wilfull ignorance: but as these men doe trouble the good state of the worlde, so the talke of them wil hinder the talke of the worlds knowledge, which is the thing that you so much long after: and therefore best it is, that we let them lie stil tumbling in the ditch of ignorance, and that we trauel forward toward the Castle of knowledge. But first let me heare what is your chiefe desire.

Scholler.

The occasion of this booke.

Sith my last talke with you about the knowledge of the worlde and the partes of it, I haue read diuers bookes that intreate of that matter, as namely, Proclus Sphere, Ioannes de sacro Bosco, Orontius Cosmographie, and diuers other, whose words in many things I remember, but of the matter I haue sundry doubts, and therefore desire much your help therein. For though I haue consulted with diuers men therein, yet me thinketh they tell mee but the same words in like sort as I read them before, or little otherwise altered, but light of vnderstanding, I haue gotten little yet.

Maister.

Then proue againe, peraduenture your chance may be better: that which at the first seemeth hard, may at length become easie: for Vse maketh masterie, al men confesse. And, The best things are not most easie to attaine. Beginne in that order as your Authours doe.

Scholler.

The diuersity of Writers.

Their orders be as diuers as their names be, so that I know not whose order is best. For Proclus intreating of the Sphere, defineth first the Axe-tree of the worlde, before he had shewed either what the worlde is, or what hee calleth a Sphere, or what neede the worlde hath of any Axe-tree. Therefore I turned to Ioannes de sacro Bosco our countryman, which beginneth first with the definition of a Sphere, but nothing like to that Sphere which I before had bought, as an apt instrument to learne by. Then see I Orontius disagree from them both: and generally, euery one from other, so that I know not where to beginne.

Maister.

As touching those Writers, I will say no more now, but although euery one of them haue some things, that exactly scanned, may be misliked, yet he that hath done worst, is woorthie of thankes, for his studious paines in furthering of knowledge. And seeing you doubt of their order, let the thing it selfe minister order. What is it that you desire to know?

Scholler.

The argument of this booke.

I see in the heauen maruellous motions, and in the rest of the worlde strange transmutations, and therefore desire much to know what the worlde is, and what are the principall partes of it, and also how all these strange sights do come.

Maister.

Maister.

Then is the world the thing that you would know first, sith all these other things are incident to it. What do your Authors call the world?

Scholler.

Orontius defineth the world to be the perfect and entire composition of all things: a diuine worke, infinite and wonderfull, adorned with all kindes and formes of bodies that nature could make. What the world is.

Maister.

This definition doeth much agree with those that be written by auncient Authors, and namely Aristotle which defineth it thus: *Mundus est compages ex cœlo & terra, & reliquis in iisdem contentis naturis.* The worlde is an apt frame of heauen and earth, and all other naturall things contained in them. The like wordes hath Cleomedes and others: so that the worlde is that entire body, which containeth al things that euer God made, and man can see, nothing excepted, but God himselfe onely, which is not comprehensible by any worldly meanes. This worke is so pure and wonderful in beauty, that it beareth the name of Cleanenesse, both in Greeke and Latine, that is, Cosmos in Greeke, and *Mundus* in Latine: and thereto alludeth Sibyll in her verses, speaking of the dissolution of the world, saying: *Erit mundus immundus, pereuntibus hominibus.* The world (saith she) shall be vncleane, or leese his beauty, when all men shal perish. Whereof the world is named.

Scholler.

And so doth that sentence leese his beauty by the translation, for there can be no such allusion of wordes in the English of that sentence, as there is in the other tongues.

Maister.

You say trueth, except a man would rather allude at the wordes, then expresse the sentence, for so might it be translated thus: It shall be an vnworldly world, when all men shall perish: But here the sense is lost: for this name World hath not the like deriuation of cleanesse in English, as the Latine and Greeke names haue in their tongues: neither can I well tell whereof this English name is deriued, although I remember some other significations of this word, as first it is vsed in Scripture for a name of long continuaunce of time, when we say: World without end, and, thorough worlde of worldes: which signifieth for euer. Also this name signifieth sometimes a great wonder, as when we say: It is a world to see the craft that some men vse vnder colour of simplicitie. Now if any man will contend, that this word World principally betokeneth a wonder, and that the world for the wonderfull shape of it, tooke that name, as the chiefe wonder of all wonders, I wil not greatly repine, but then must I needes wonder, to see the chiefe worldly men to wonder so little at this wonderfull wonder, and to bend all their studie to the Diuers significations of the word world.

centre of the woꝛld, I meane the Earth, which in comparison to the whole woꝛld is not only a part without all notable quantitie, but also leaſt adoꝛned with maruellous woꝛkes, and moſt ſubiect to all fraile tranſmutation and change, ſtill repleniſhed with continuall coꝛruption. And yet on it onely doth the greateſt number ſet all their ſtudie. Foꝛ it they ſuſtaine great trauaile and toile: foꝛ it they chide, quarrell and fight: to get it they venture their life and limme, and when they thinke moſt aſſuredly that they haue gotten the Earth, then indeede the Earth hath gotten them, and moſt commonly then doth the earth conſume them, when they thinke themſelues ful maſters of it.

Scholler.

By theſe mens trauel (I thinke) it came to paſſe, that the Earth doth vſurp the name of the Woꝛld, as though it were all, and that beſides it were nothing.

Maiſter.

The ſmalneſſe of the earth to the whole woꝛld.

Thereof commeth that common pꝛouerb of a couetous man: All the woꝛld is too little foꝛ him; where hee indeede ſeeketh nothing but the earth, which earth in compariſon to the whole woꝛld beareth no greater view, then a muſtard coꝛne on Malboꝛne hilles, oꝛ a dꝛoppe of water in the Ocean ſea, foꝛ of all the partes of the woꝛlde, the earth is the leaſt, and that without compariſon, as hereafter I ſhall not onely tell you, but alſo pꝛoue it by inuincible reaſon. And therefoꝛe to pꝛoceede in our matter, I thinke it beſt, not only to make diſcourſe lightly of the pꝛincipal parts of the woꝛld, but to do it in ſuch a bꝛiefe ſoꝛte, as the minde may conceiue it ſooneſt, and the memoꝛie alſo retaine it longeſt: and therfoꝛe wil I omit al pꝛoofes, til we haue once generally dꝛawen the image of the whole woꝛlde: ſo ſhall not your memoꝛie be troubled with ſundꝛy things at once, as in learning a ſcience which ſeemeth ſomething ſtrange, and in conceiuing the reaſons of it, which in declaring, ſeeme much moꝛe ſtrange.

The beſt oꝛder in teaching.

Scholler.

Indeede I haue felt the diſcommoditie of ſuch haſtie deſires: foꝛ where I haue ſought reaſon, befoꝛe I vnderſtoode whereto that reaſon tended, I haue troubled my minde, and hindered my knowledge: wherefoꝛe it may pleaſe you in your oꝛder to pꝛoceede.

Maiſter.

The oꝛder of the elements.

I haue already ſaid, that of all the parts of the woꝛld the earth is the leaſt: whereby you may conceiue, that within it is nothing: foꝛ ſo ſhoulde that (whatſoeuer it were) be leſſer then the earth: but without the earth doth the water lie, which couereth a great part of the ſame: about them both doeth the ayꝛe runne, and occupieth (as wee may eaſily conſider) much moꝛe roume, then both the ſea and the land: aboue the ayꝛe, and round about it, (after the agreement of moſt wiſe men) doeth the fire occupie his place. And theſe foure,

foure, that is, Earth, Water, Aire and Fire, are named the foure Elements, that is to say, the first, simple and originall matters, whereof all mixt and compound bodies be made, and into which all shall turne againe.

All things compound are made of the foure elements

Scholler.

Oftentimes haue I heard it, that both man and beastes are made of earth, and into earth shall returne againe: but I thought not that they had beene made of water, and much lesse of ayre or fire.

Maister.

Of earth onely, nothing is made but earth: for an herb or tree can not grow (as all men confesse) except it be helped and nourished with ayre conuenient, and due watering, and also haue the heate of the sunne: and generally, sith all thing is maintained by his like, and is destroyed by his contrarie, then if man cannot be maintained without fire, ayre and water, it must needes appeare: that he is made of them, as well as of earth, and so likewise all other things that be compound.

Scholler.

This talke delighteth me maruellously, so that I can not be weary of it, as long as it shal please you to continue it.

Maister.

This talke is not for this place, partly for that it is more physicall than astronomicall: and partly because I determined in this first part, to omit the causes and reasons of al things, and briefly to declare the partes of the world, whereof these foure Elements, being vncompound of themselues, that is, simple and vnmixt, are accounted as one part of the world, which therefore is called the Elementarie part: and because those elements do daily increase and decrease in some partes of them (though not in al parts at once) and are subiect to continual corruption, they are distinct from the rest of the world, which hath no such alteration nor corruption, which part is aboue all the foure Elements, and compasseth them about, and is called the Skie, or Welkin, and also the Heauens: this part hath in it diuers lesser or special partes, named commonly Spheres: as the sphere of the Moone which is lowest, and next vnto the Elements: then aboue it, the sphere of Mercury: and next to it the sphere of Uenus: then followeth the Sunne with his sphere: and then Mars in his order: aboue him, is Iupiter: and aboue him, is Saturne. These seuen, are named the seuen Planets, euery one hauing his sphere by himselfe seuerally, and his motion also seuerall, and vnlike in time to any other. But aboue these seuen planets, is there another heauen or skie, which commonly is named the Firmament, and hath in it an infinit number of stars, whereof it is called the starry skie: and because it is the eight in order of the heauens or spheres, it is named also the eight Sphere. This heauen is manifest enough to all mens eies, so that no man needeth to doubt of it, for it is

The elements are simple.
The elements do alter daily in their parts.
The skie.
The order of the Spheres.
The seuen planets.

that skie, wherein are al these starres that we see, except the fiue lesser planets, which I did name before, that is, Saturnus, Iupiter, Mars, Uenus, and Mercury.

Scholler.

The Sunne and Moone also must be excepted out of that number, for they haue their spheres by themselues, as well as the other planets.

Maister.

Trueth it is, but bicause no man doth account them as starres, therefore they neede no exception, where mention is made of starres only, whereas the other fiue smaller planets (which I named before) are so like other stars, that no man, but such as are of good experience in Astronomie, can discerne them from the other starres, though many men do make a difference of them by twinkling, affirming that the fixed-stars do twinckle, and not the planets, with other differences difficult to obserue, and scarce certaine in distinction. But this is their most certaine difference, that al those starres which be in the firmament, do stand and continue in one forme of distance ech from other, and change not their places in the sphere, and therfore be they called Fixed stars: for though they go round about the world in 24. houres, that is, euery day once, yet they keepe their places in their sphere, and turne onely with their sphere: or (as Aratus saieth) they be drawen with their heauen, whereas the seuen planets are not onely carried round about the earth with the like motion of heauen euery day, but they do moue of themselues, and do change their places in their owne spheres, and for that cause are they called Planets, that is to say, Wandering starres.

How the planets are known from other starres.

Scholler.

Oftentimes haue I heard this, but yet can I not tel how to perceiue it.

Maister.

That shal be referred to the fourth Treatise, where I wil shew you the proofe of al that you shal thinke doubtful.

Scholler.

Yet I beseech you let mee knowe this, Why are those heauens called Spheres: for (in my fantasie) they are nothing like that instrument of sundry circles, which is commonly called the sphere, sith neyther can I see in them such circles as are in that materiall sphere: neyther is there in the materiall sphere any such representation of such diuers heauens, neither of such varietie of starres.

Maister.

This doubt was mooued before now, by Ioachim Ringelbergh, in a Treatise that he wrote of the sphere, but it shall be answered easily by your selfe after a little declaration of the celestial Spheres. And for that cause, I wil omit it til anone, and wil first declare certaine other accidents of the heauens,

uens, and of the other partes of the woꝛlde.

Hitherto you haue heard only the names of the partes of the woꝛld, and of their ſituation, how they be placed in oꝛder. Now foꝛ the foꝛme and ſhape of them, you ſhal vnderſtand, that the whole woꝛlde is round exactly as anie ball oꝛ globe, and ſo are al the pꝛincipall parts of it, euery ſphere ſeuerally and ioyntly, as well of the Planets, as of the Fixed ſtarres, and ſo are al the foure Elementes. And they are aptly placed togither, not as a number of round balles in a net, but euerie ſphere includeth other, as they bee in oꝛder of greatneſſe, beginning at the eight ſphere oꝛ firmament, and ſo deſcending to the laſt and loweſt ſphere which is the ſphere of the Moone: vnder which the foure Elementes ſucceed: firſt the fire, then the aire: next followeth the water: which with the earth ioyntly annexed, maketh as it were, one ſphere onely.

The foꝛme of the woꝛld and his partes

Scholler.

This I doe well vnderſtand in woꝛds, and the eaſier by this picture, which I finde in euery booke of the ſphere, but that I ſee there moꝛe ſpheres, then you ſpeake of: foꝛ in ſome bookes mention is made of nine ſpheres, and in other are ten ſpheres named, where you ſet foꝛth but eight.

Maiſter.

The cauſe of this diuerſitie will I in the fourth treatiſe declare: in the meane ſeaſon, I thinke it beſt to tell you of no mo ſpheres, then are perceptible by ſight, foꝛ ſo manie are we certaine of. And therefoꝛe vnderſtand you thus, that as the eight ſphere is the greateſt, and hath none other without him that may be ſeene, ſo the earth is the leaſt, and hath none other within him,

The earth is the centre of the woꝛld.

The earth hath no quantitie in reſpect to the woꝛld,

him, but it standeth in the middle, and in the centre of the whole world, and of euerie one of these spheres, and therefore it is called the Centre of the world: so that although the earth in it selfe haue a great and notable quantitie, yet in comparison to the firmament, it is to bee esteemed but as a centre or little pricke, yea in deed much lesse then any notable starre that you see; and if I shall speake boldly that which I intend hereafter to prooue certainly, the earth is lesser then the least starre in the firmament which is commonly seen, but yet is it greater then Venus or Mercurie, yea greater then the Moone.

Scholler.

This affirmation seemeth to me impossible, or at the least contrary to sence: For the Moone seemeth bigger much then anie starre, yea somewhat bigger then the sunne.

The earth hath no motion.

Maister.

Content your self to credite me, till time serue for the proofe of my words, and in the meane season, to proceed as I began. You must thinke, that the earth and the water annexed togither in one globe, are of no notable quantitie, in comparison to the firmament, and that it standeth as the centre of the world, and hath no motion out of his place, neyther yet circular mooving about his owne centre, but resteth (as we may say) quiet without al such mooving. Likewise must you thinke of the other elementes, which of their owne nature haue none other motion then a stone or a light feather, so that they may be accompted all foure to be without natural motion.

Scholler.

Yet in the water, and in the aire, we see euery day notable mooving. And sometime I haue heard of mooving of the earth, by earthquakes: and as for the fire that we see, it alwaies mooueth and flickereth in burning.

Maister.

And so you haue seene a stone moone swiftly, when it fell from any high place: but these motions haue an end quickly, except they be continued with violence, as hereafter I will sufficiently declare. But as the stone although it will moue in falling, yet in his place lieth quiet without motion: so the earth it selfe, and the other elementes must be accompted quiet by nature, and without motion.

The motions of the heauens

¶ The heauens contrarywise haue such a natural motion that neuer resteth night nor day, neither can be staied by any violence. This motion wee see in the heauens dayly by their mooving from the East to the West, and from the West to the East againe, about the earth, once euery 24. houres, and therefore is this motion named the Daily motion, for it is the measure of a Naturall day, commonly accompted. And this motion is likewise called of ancient writers the motion of the first Firmament, according to which motion you see the Sunne in the day time, and the Starres in the night time,

and

and the Moone both in the day and the night, to paſſe from the Eaſt into the South, and ſo into the Weſt, and at the end of 24. houres to come againe into the Eaſt: whereby you may eaſily vnderſtand, that this motion is common to all the ſpheres of heauen.

Scholler.

This may al men ſee, that can ſee any thing. Yet haue I heard of ſome ſo groſly witted, that they doubted which way the ſunne and the moone came into the eaſt againe, as though they did not thinke that the ſkie did moue about the earth.

Maiſter.

Such groſe ignorance hapned ſometimes to famous men, for laeke of due conſideration of that which all men may ſee, as I will in place conuenient more largely note.

Scholler.

One doubt more I haue, of which I would gladly be ridde, and that is of the moone: for as you ſay, and by ſight we perceiue, all the ſtarres with the ſunne and moone, goe rounde about the earth in 24. houres, ſaue that the moone is ſlacker then all the reſt, for ſhe is euery day later in riſing by an houre, then ſhe was the day before: but how that commeth to paſſe, I doe not vnderſtand.

Of diuers motion in the moone.

Maiſter.

This doubt is well mooued, and in good time, for by it wil I take occaſion to inſtruct you, not only in the true knowledge of it, but alſo of other ſundry motions in al the heauens: for in euery one of them doth there appeare a like motion, contrary to the daily mouing of the firmament, which in the moone is ſwifteſt, and therefore may be perceiued daily of all men: but in the ſunne it is not ſo ſwift, and therefore not ſo eaſily perceiued, yet all men ſee a great alteration in the mouing of the ſunne in one yere: for ſometimes he is higher and nearer ouer our heads, and ſomtime further from our heads, and lower in the ſouth: yea ſometime he ſhineth with vs almoſt 18. houres, (as in the middle of the Summer) and in the middle of the Winter he ſhineth but 6. houres, or little more:) this euery childe doth ſee, although they knowe not the reaſon thereof.

Of ſeuerall mouing in the ſunne.

Scholer.

Yet the reaſon of that is eaſie enough to be conceiued, for when the day is at the longeſt, the ſunne muſt needs ſhine the more time: and ſo muſt it needs ſhine the leſſer time, when the day is at the ſhorteſt: This reaſon I haue heard many men declare.

Maiſter.

That may wel be called a crabbed reaſon, for it goeth backeward like a crabbe. The day maketh not the ſunne to ſhine, but the ſuune ſhining makes the day. And ſo the length of the day makes not the ſunne to ſhine long, nei-

ther the shortnesse of the day causeth not the sunne to shine the lesser time, but contrarywise, the long shining of the sunne makes the long day, and the short shining of the sunne makes the lesser day: else answer me, what makes the dayes long or short?

Scholler.

I haue heard wise men say, that summer maketh the long dayes, and winter maketh the long nights.

Maister.

They might haue saide more wisely, that long dayes make summer, and short dayes make winter.

Scholler.

All that seemeth one thing to me.

Maister.

Is it all one to say, God made the earth, and, The earth made God? Couetousnes ouercommeth all men, and, All men ouercome couetousnes?

Scholler.

No not so, for heere the effect is turned to be the cause, and the agent is made the patient.

Maister.

So is it to say, Summer maketh long daies, where you should say: Long dayes make summer.

Scholler.

I perceiue it now, but I was so blinded with the vulgar errour, that if you had demaunded of me further what did make the summer, I had beene like to haue answered, that greene leaues do make summer: and the sooner by remembrance of an olde saying: that a peare should come, in which the summer should not be knowne, but by the greene leaues.

Maister.

Yet this saying doth not import, that greene leaues do make summer, but they betoken summer: so are they the signe, and not the cause of summer.

Scholler.

So I perceiue now, that the long shining of the sunne doth make the daies long. But now can I not tel what causeth the sunne to shine longer one time of the yeare then another.

Maister.

That is it that haue wisemen to search, and marke the motions of the sun, whereby at length they found, that the sunne hath another course, contrary to the daily motion of the skie. And as the moone doeth accomplish her proper course (which is from the west into the east, contrary to the dayly motion) euery moneth in the yeare, so the sunne doth ende his course, in his proper motion, but once in the yeare. And to expresse it aptly, I must say, that the

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true terme of a yeere is nothing elſe, but the very time of the courſe of the ſunne from a certaine point in heauen, vntill his returne to the ſame point againe. And a month is the iuſt time of the proper courſe of the moone, from change to change: and euery quarter of the moone maketh a weeke: of which I will ſay more in the next Treatiſe, with the declaration of the diuerſitie for the beginning of moneths and yeeres. But nowe to continue our principall matter the more orderly, I would haue you repeate the chiefe articles of our talke hitherto. A month. A weeke.

Scholler.

This is the ſumme of all your doctrine hitherto.

1 That the worlde is that entire body, which containeth in it all the heauens and the elements, with al that in them is. The firſt repetition.

2 The parts of the world are two eſpeciall, the heauens which are eight in number, and the elements which are foure in kinde.

3 The order and ſituation of all theſe parts, as wel elements as heauenly ſpheres, beginning at the higheſt, and proceeding to the loweſt, is this, the Firmament, Saturne, Iupiter, Mars, the Sunne, Uenus, Mercury, and the Moone.

The foure Elements.

Fire, Ayre, Water, and Earth: and euer the higher incloſeth all that is vnder it.

4 The world and al his principall parts are round in forme and ſhape, as a globe or ball.

5 The earth is in the middle of the world, as the centre of it: and beareth no view of quantitie in compariſon to the world.

6 The earth hath no motion of it ſelfe, no more then a ſtone, but reſteth quietly: and ſo the other elements do, except they be forcibly moued.

7 The heauens do moue continually from the eaſt to the weaſt, and that motion is called, The daily motion: and is the meaſure of the common day.

8 The moone hath a ſeuerall motion from the weaſt towards the eaſt, contrary to that mouing of the daily courſe, and that motion is the iuſt meaſure of a moneth, and euery quarter doth make a weeke.

9 The ſunne alſo hath a peculiar motion from the weſt toward the eaſt, which he accompliſheth in a yeere, and of that courſe the yere taketh his meaſure and quantitie. Now then it may pleaſe you to proceede to further explication of the apparances which are noted in the heauens, and to ſhew the manner of their motions.

Maiſter.

To the intent you may vnderſtand all things the more eaſily, I thinke it good to deſcribe vnto you a materiall ſphere, which ſhall containe in it ſuch notable circles onely, as haue ſpeciall vſe in the declaration of the heauenly A materiall ſphere.

motions, and such as reason shal driue a man to appoint, as certaine bounds of the motions in the heauens: yea such I say, as your selfe shall by interrogatories be constrained to confesse needefull to that knowledge you desire.

Scholler.

If nothing be placed in that sphere, but that which must needs be had, then can I not account any part of it superfluous. And againe, if it serue sufficiently to instruct mee in that I desire to knowe, I can not iustly blame it in any point as insufficient, so must it needs be a perfect instrument, void of default, and without superfluitie.

Maister.

So shall it be, for so much as this part of knowledge requireth. Now then to beginne: ye do beleeue that the world is round.

Scholler. Yea forsooth. Maister.

The making of a globe. Then must that instrument also be round which shall aptly expresse the forme of the world.

Scholler. Trueth it is.

Maister.

Can there be any thing more round then a circle?

Scholler.

No truely.

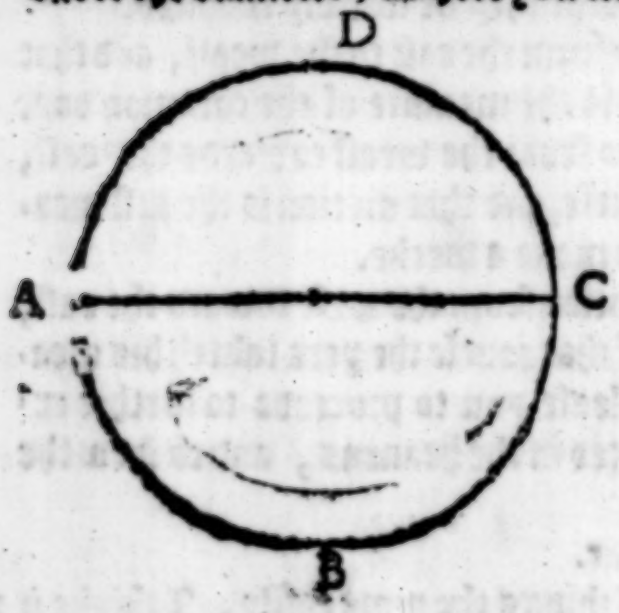
Maister.

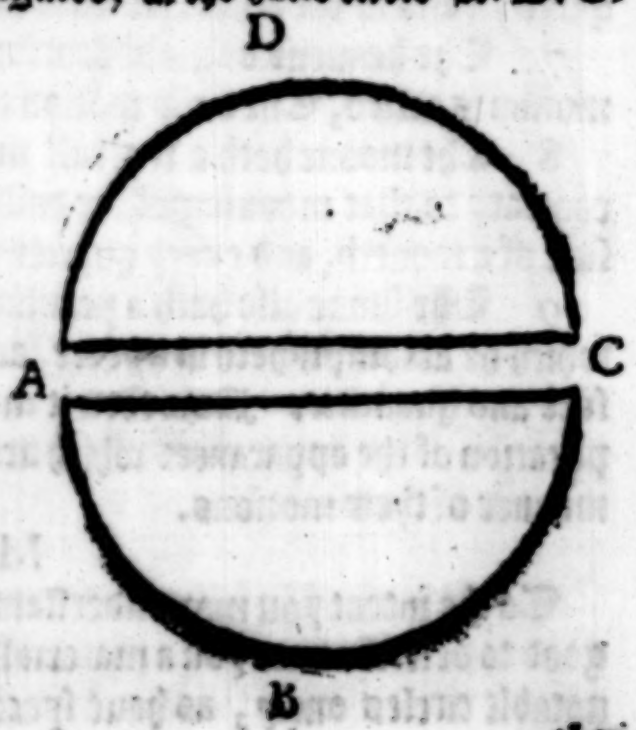
And doe not two halfe circles make a whole circle?

Scholler.

It cannot be denied. Maister.

Then take halfe a circle, and fasten it on an axe tree, or on any diameter, and then turne it round about, first letting the halfe circle hang downeward vnder the diameter, as here you see it figured; in the halfe circle A. B. C.





then

then turne the halfe circle right vp ouer the diameter, as here alſo is repre-
ſented in the halfe circle A, D, C. do not theſe two poſitions make a whole
circle?

Scholler.

Yes ſurely.

Maiſter.

Then ſet the halfe circle ſo, that the diameter may ſtand ſtill firmely fixed,
and the halfe circle may turne round about. Doe not you imagine now that
euery diuers poſition of this halfe circle with the contrarie placed againſt it,
doth make a whole circle?

Scholler.

Yes verily.

Maiſter.

And becauſe there is no place round about that diameter, within the reach
of that halfe circle, but that halfe circle hath paſſed it, there can no voide
place be aſſigned, but it is occupied and filled with halfe a circle, and euerie
halfe circle with his contrary doth make a whole circle, ſo doth this whole
reuolution of the halfe circle make a iuſt circular bodie.

Scholler.

So it appeareth truely.

Here is the like forme of that worke.

Maiſter.

This circular body is named a ſphere, as it may appeare by the deſcrip- A ſphere is de-
tion that Euclide maketh of a ſphere: which is thus in Latine, as himſelfe fined.
wrote it, in his eleuenth booke of Geometry.

Sphæra eſt figura comprehenſa ex circumductu ſemicirculi, donec eò redeat, vnde moueri incœpit, manente interim immota ſemicirculi eius diametro. And
thus it ſoundeth in Engliſh.

A ſphere is a ſound figure, made by the turning of halfe a circle, till it

end where it began to be mooued, the diameter of that halfe circle continuing steady all the meane while.

This description doth *Iohannes de Sacro bosco* expound thus: that a sphere is a round and sound bodie made by the turning of halfe a circle.

Scholler.

So that a sphere is nothing els but a round and massie bodie closed with one platforme, which you in your Pathway doe call a Globe.

Maister.

The centre of a Globe or Sphere.

You take it right. But now must you marke, that as a circle is made about his centre, so a Globe also hath his centre, as you may easily understand, from which center all the lines that may be drawne to the platforme, or vtter part of the globe, are al equall togither, according to Theodosius definition, which saith thus: A sphere is a massie bodie, inclosed with one platforme, and in the middle of it, there is a pricke, from which all lines drawne to the said platforme, are equall eche to other, and that pricke is the centre of the globe, and so saith Euclide also.

Idem centrum sphæræ est, quod & semicirculi.

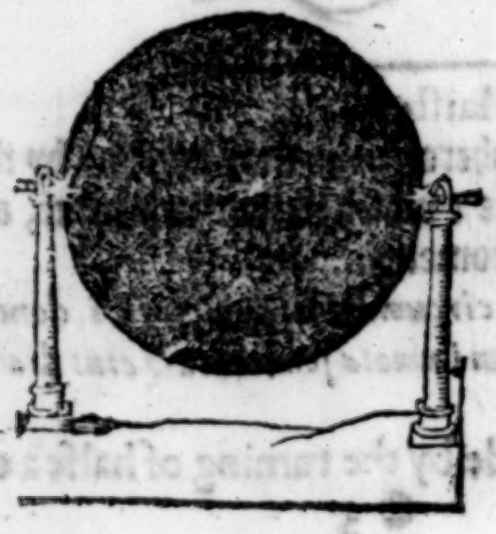
The centre of a globe is the same centre that the semicircle hath, by which the globe was made. Scholler.

It must needes be so: and likewise the diameter of them both must needes be al one, as I thinke. Maister.

A Diameter and an Axe tree differ.

You say not much amisse, Yet must you put a difference in a globe, betweene a Diameter and an Axe-tree. For euery right line that passeth from side to side in a globe, and toucheth the centre, is aptly called a diameter. So, that as there may be many diameters in a circle, so may there be as many also in a Globe: But of al that multitude, one only is called the Axe-tree, and that is it on which ỹ globe turneth. This difference did *Ioannes de Sacro bosco* ouerpasse, not ignorantly, but negligently, or els wittingly: but so did not Euclide, which defineth them both thus. *Axis Sphæræ est, recta illa stabilis linea, circa quam semicirculus rotatur.* The Axe tree (saith he) is that right line which mooueth not, but the half circle moueth about it. These words haue respect not onely to the making of a Globe or Sphere, but also to the vse of it. But now the diameter is defined by him thus. *Dimetiẽs vero Sphæræ est, recta quæq; linea per centrum acta, & vtrinq; desinens in sphæræ superficie.*

An Axe-tree.



A diameter.

The

The diameter of a Sphere, is any right line that is drawen by the centre, and ended in the platforme of the sphere.

Scholler.

This difference must needes seem reasonable, sith there may be so many diameters drawne as a man listeth, but Axe-trees there can be but one in one globe.

Maister.

When a globe turneth round, are there anie mo pointes then two in that globe, on which it doth turne:

Scholler.

By proofe it appeareth, that al partes of the globe moue, except the two endes of that Axe-tree, wheron it mooueth, and they moue not out of their place.

Maister.

Those two pointes are named the poles in a sphere: whereby also you may vnderstand, that there can be but two poles in one sphere. Marke this well, for it will serue your turne in place conuenient. Now apply all these to the world, which in his whole substance is round, and therefore aptly may be called a sphere: you see it turne about round, and therefore must it haue two poles, on which it turneth so. Also because it is round, it must haue a centre (which I did affirme before to be the earth) and by this centre we may imagine a right line to runne from the one pole to the other, which right line must be called the Axe-tree of the world. Poles of a Sphere.

Scholler.

For the centre of the world, it must needes be something: for I perceiue a globe cannot be but it must needs necessarily haue a middle pricke or centre, no more then a line may be made which hath no middle, or a cirrle that hath no centre: which both appeare vnpossible. Also for the poles, they appeare needfull, or rather of necessitie to followe the mooumgs of heauen. For in al round thinges that moeue roundly, there be such two pointes that seeme not to moeue: but why there should be anie axe-tree required in the world, I see no reason: for if the mightie power of God did not stay the world, there could be no Axe-tree able to beare it.

Maister.

Your imagination in this point is too grosse. I said not that the Axe-tree was made to stay the world, but that it passeth as a line onely from the one pole to the other: and is not without great and profitable vse, both in doctrin, and also in practise, for placing of instrumentes, as you shall knowe better hereafter. But now heare how Proclus doth apply these to the world: Which wordes our worthy countreyman D. Linaker, setteth downe thus.

Axis mundi vocatur dimetiens ipsius, circa quam voluitur. Axis extre-

mus,

mundi (seu vertices) sunt nominati: horum alter Septentrionalis, alter Austrinus dicitur.

The Axe-tree of the world, is named the Diameter of it, about which it turneth: And the endes of that Axe-tree, are called the Poles of the world, of which Poles one is named the North pole, and the other the South Pole.

The North & South Poles.

The North pole is alwaies seene of vs wheras we dwell, and the South pole is neuer seene in this our countrey, but is euermore vnder our Horizonte, and that as lowe, as the North pole is high aboue our Horizonte.

Scholler.

I haue been caught to know the Northpole, and I haue marked it oftentimes, wherby I haue perceiued a great number of stars to mooue about it, & were sometimes higher then it, and sometimes lower then it: Now on the East side of it, and now on the West side: but that pole starre seemed not to stirre out of his place at anie time: whereby I gather, that hee is neuer out of sight to vs, when the starres appeare, and that is all the night: but what becommeth of him in the day time, I cannot tell.

Maister.

The Horizonte

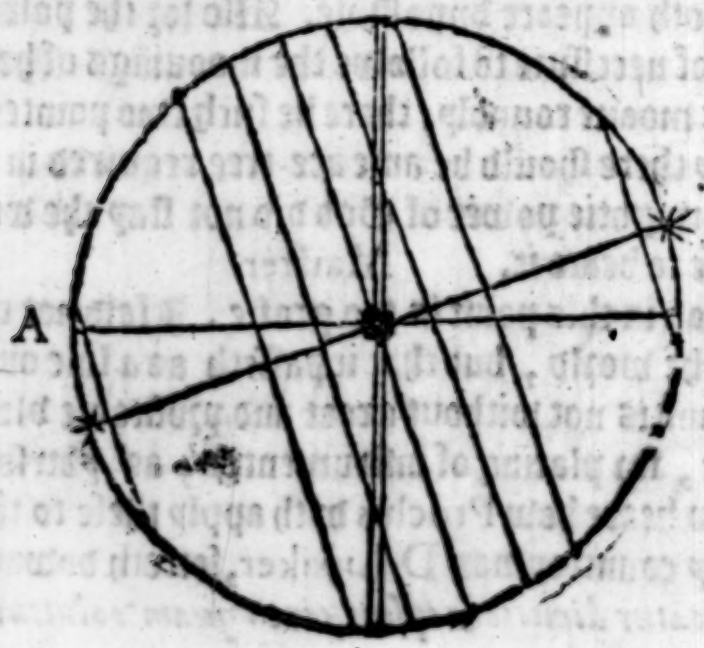
I will cleere you of all such doubtes before I leaue you: but in the mean time, I maruell you found no doubt at the name of the Horizonte.

Scholler.

That name I learned to signifie that circle, which goeth along by the edge of the ground, and parteth that part of the world which wee see, from that part which we see not: and when the Sunne riseth, then is he in our Horizonte, and so is he, when he is going downe as lowe as we can see him.

Maister.

Here the Horizonte is represented by the line, A C.



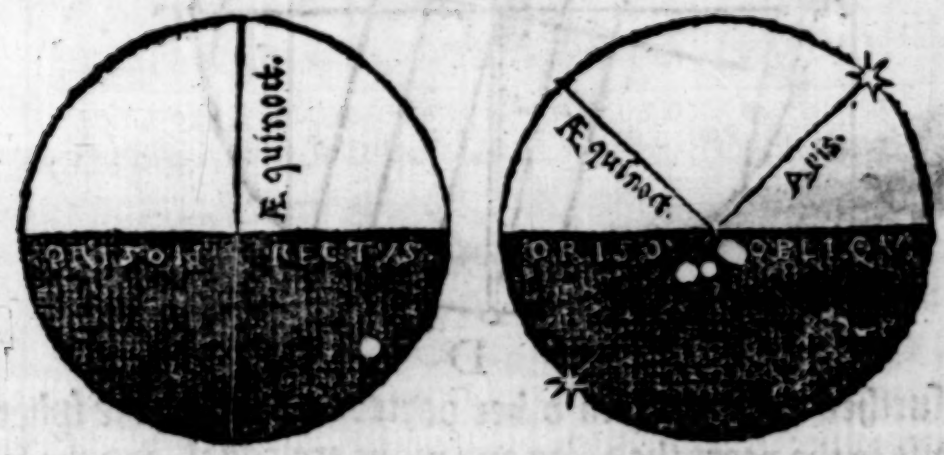
This

This is not greatly amiſſe. The like expreſſing of it doth Hyginius vſe in his firſt booke, and in the iiii. alſo of his aſtronomie: but Proclus in his Sphere, doth define it thus.

Horizon vero circulus eſt, qui conſpectam mundi partem ab inconſpecta dirimit: itaq; in duas partes vniuerſam Spheram ſecat, vt alterum hemiſphærium ſupra terram, alterum ſub terra relinquat.

The Horizonte is a circle which parteth that part of the world that we ſee, from that which we ſee not: and it diuideth the whole ſphere of the world into two equall parts, in ſuch ſorte, that half of that ſphere is euer aboue the ground, and half alwaies vnder the earth. This circle

¶ And here the Horizonte is the edge betweene the light part (which ſtandeth for that which we ſee) and the darke part which doth ſignifie that which we cannot ſee of the skie.



you perceiue to be neceſſaris in the materiall ſphere, ſeeing it hath ſo great vſe in the heauenly motions, that by it we iudge the riſinges and ſettinges of the Sunne and the Moone and al other ſtarres. What ſay you then for the noone-ſteede of the day, from which you recken all your houres, as it appeareth both by the clockes and dials: for as the clocke ſtriketh one next after noone, and ſo increaſeth forward in the number of houres, ſo likewiſe are your houres marked in the dials. The Meridian circle.

Scholler.

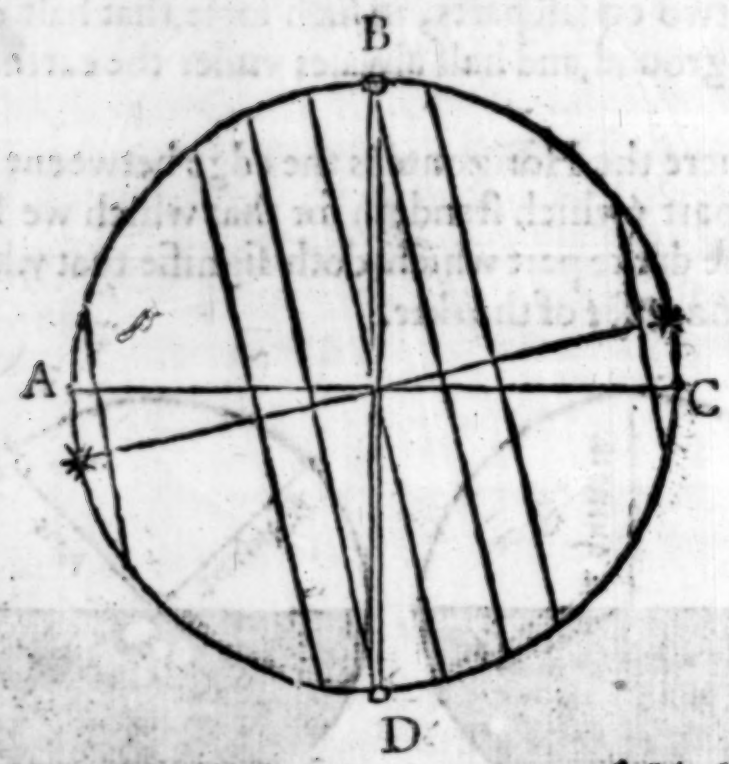
I thinke it very meete to haue the South point well knowne, as wel for to know the noone time of the day, as for ſtanding dialles, and for knowledge of the time of the night by the moone, and by other ſtarres.

Maiſter.

Then muſt there be a circle appointed for that vſe, which is called therefore the Meridian circle, and may be named wel the noone-ſteed circle. This circle is thus defined by Proclus.

Meridianus circulus est, qui per mundi polos & punctum, quod nobis supra verticem eminet, ducitur. In quem cum sol incidit, medios dies, mediasq; noctes efficit. The Meridian is a circle drawn by the poles of the world, and the point right ouer our heades. In which circle when the sunne is, hee maketh the middle of the day, and the middle of the night.

The Meridian circle here is resembled to the circle A,B,C,D.



Nowe, further to proceed to other partes needful in the sphere. You do see, that twise in the peare the daies and night are equal, and the sunne riseth in the iust East, and goeth downe in the full West, whereas in the summer the sun riseth North-east, and setteth North west: and at noontide is verie high ouer our heades: but in the winter, contrariwise the sunne riseth South-east, and setteth South-west: and at noonetide is very low. Thinke you not that these three boundes of the course of the sun would be wel noted, and haue their peculiar circles, for distinction of those times?

Scholler.

I thinke nothing more needful then that.

Maister.

These three circles (with two other that I wil nert speake of) are named the fiue Paralelles: and the middle circle of those, is named the Equinoctial, because that when the sunne is vnder it, the dayes and nights are equall in al the world, except only two places. This circle is thus defined by Proclus.

The Equinoctiall circle.

Aequator, circulus is est, qui maximus aequidistantium circulorum statuitur, ita nimirum ab Horizonte dissectus, vt alter eius semicirculus supra terram, alter sub terra condatur: in hoc sol duplex aequinoctium, vernum autumnale;

leg; facit. The equinoctiall circle is the greatest of the fiue Parallele circles, and is diuided so equally into two partes, by the Horizonte, that the one half of it is aboue ground, and the other is vnder the Horizonte: and when the sunne is in this circle, he maketh the dayes equal with the nightes, once in the Spring time, and againe in the Haruest.

This Equinoctiall circle and the other seuen that follow to bee declared, do moue al as the skie moueth. But the Horizonte and the Meridian doe not moue with the heauen, but stand steady, and keep their places.

Scholler. That seemeth reasonable, els could not men know the rising, setting, and noonestead of the Sunne. But how shal I know this Equinoctiall circle in heauen, seeing I cannot see any such circle there?

Maister. Marke the course of the sun about the 11. day of March, or els about the 14. of September, and so may you best vnderstand the place of this circle, for at those 2. times the sun runneth directly vnder ỳ Equinoctial circle, and doth (as it were) describe it by his motion, in foure & twenty houres. And if you list to marke the rising of Sun that day, you may knowe the precise point of the East, and at night he setteth in the iust point of the West.

How to know the place of the circle Equinoctial.

Scholler. I would I knew as good markes of the other circles.

Maister.

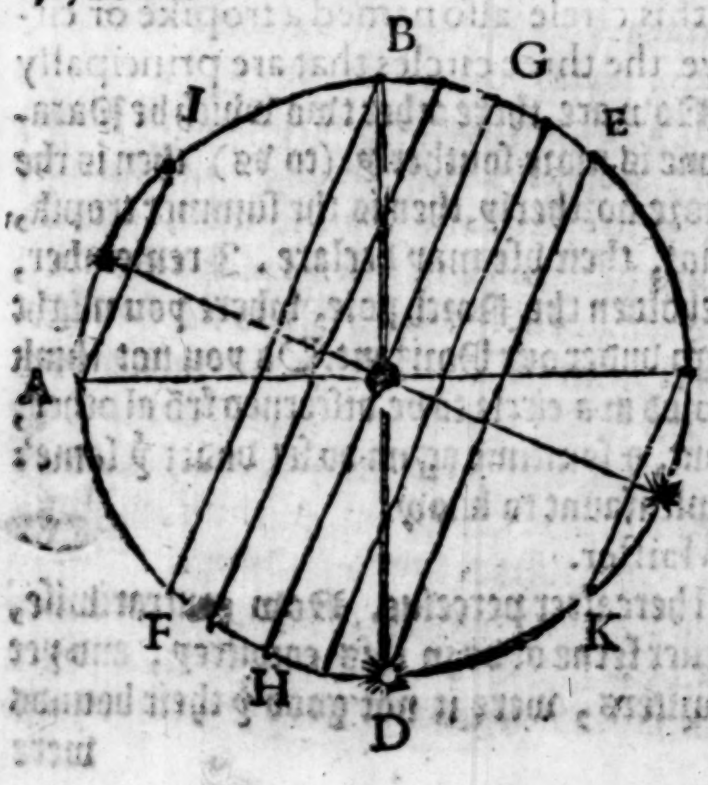
So will I giue you in their conuenient places and times good orders to know them al: and first I must tel you, that these other two circles, which I named before (with ỳ Equinoctial) are called the ii. tropike circles, after the Greeke deriuation, and may be called in English the sun bounds, because the sun doth neuer passe thẽ, neither towards the North, nor yet toward the South: but when he toucheth any one of thẽ, he doth turne his course toward the other. As for example: At the time from the middle of December vntill the 11. day of June, you may perceiue the sun to rise higher and higher, and that day he is at the highest that he can go towardes our heades, and then doth he by his course describe ỳ Summer tropike, after which day he draweth again lower and lower euery day, till the 12. day of December, for then he is at

The knowledg of the 2 tropikes.

The Summer tropicke.

¶ *Examples of those Circles and other that follow.*

A, C, the Horizonte. ** The poles of the world.
G, H, The Equinoctiall circle. B, E, one Tropike, and E, D, the other tropike. A, I, the artike circle. C, K, the antarticke circle.



The Winter tropike.

the loweſt, and that day he doth deſcribe the Winter tropike. Nowe marke how Proclus deſineth them. * *Solſtitialis autẽ circulus is eſt, qui omnium, qui à ſole deſcribuntur maximè ſeptentrionalis habetur. In quem quum ſe ſol receperit, æſtiuam reciprocationem peragit, longiſſimuſq; totius anni dies, breuiſſimaq; nox erit. Poſt hanc autem reciprocationem, nequaquam vltra, verſus ſeptentriones ſolem progredi, quin potius ad diuerſa mundi regredi cernas. Vnde & Tropico græce nomen.* The Summer tropike is the moſt northerly circle of al thẽ that the ſun deſcribeth: in the which when the ſun is, he maketh his ſummer turn, at which time is the longeſt day of al the yeare, and the ſhorteſt night: for after this ſummer turne, you ſee the ſun go no more toward the north, but turneth to the contrary coaſt of the world, and thereof is that circle named (in Greeke) a Tropike: that is to ſay, a Returning circle, or a circle of Returne. The ſunne after he beginneth to turne, may be perceiued euery day, or at the leaſt euerie weeke, and chiefly at noonetide to ware lower and lower, vntil he come to the Winter tropike, and there he turneth againe, as by the deſinition of that tropike you may vnderſtand. *Brumalis circulus is eſt, qui omnium circulorum qui à Sole circumactu mundi deſcribuntur, maximè ad auſtrum pertinet: in quo ſol brumalem reciprocationẽ facit, maximaq; totius anni nox, miniumuſq; dies efficitur. Poſt hanc metam nequaquam vltra progreditur * ſol, ſed ad alteras mundi partes reuertitur: vnde tropicus hic quoque, quaſi verſilis, appellatur.* The winter tropike (ſaith *Proclus*) is the moſt ſoutherly circle of all them that the ſun doth deſcribe, by the reuolution of the world, in which when the ſun is, he maketh his Winterly turne, and then is the longeſt night in all the yeare, and the ſhorteſt day: for after this Winter turn, the ſun is not ſeen to go anie farther toward the ſouth, but turneth to the contrary coaſtes of the world, and therof is this circle alſo named a tropike or circle of Returne. And thus haue we the three circles that are principally noted for the courſe of the ſun. Now are there other two which be Parallelles with theſe three, wherof the one is more ſoutherly (to vs) then is the Winter tropike, and the other is more northerly, then is the ſummer tropik, which whether they be needfull or not, their vſe may declare. I remember, that you ſaid, you had oftentimes beholden the North pole, where you might ſee many ſtars about it, that neuer go vnder our Horizont. Do you not think it good that al thoſe ſtars were incloſed in a circle to be diſcerned frõ al other, which riſe ſomtime aboue ꝑ Horizont, & ſomtime again do ſet vnder ꝑ ſame?

Linacer nimium coacte commune nomen vtrique tropico attribuit, Plinium importune ſecutus.

The winter tropike.

Intelligẽ verſus auſtrum quod & græce additur.

The fourth & north circles.

Scholler. Yes verily, it were pleaſaunt to know.

Maiſter.

The vſe of the Arctike, and Antarctike circle.

And profitable alſo, as you ſhall hereafter perceiue. Now contrariwiſe, there are other ſtarres, that are neuer ſeene of vs in this countrey, and yet much mention is made of them in writers, were it not good ꝑ their bounds were

were marked, that all other may be knowne from them?

Scholler.

Else might men often looke for such starres as they reade of, and should loose their labour, for they shall not see them.

Maister.

And yet are there goodly bright and notable starres, which are not seene here: but in south Spaine, in Barbary, in Guinea and Calecut, and manie other countries, they appeare faire and pleasant to behold.

Scholler.

I pray you, what call you those circles that incloseth those starres?

Maister.

They are named after the coast of the world where they be. So that the circle which incloseth all those starres that be about the north pole, is named the Arctyke circle, or North circle: and the contrary circle in the south, is called the Antarctike circle, by the Greek composition, as you would say, Contrary or against the Arctike circle: and it may well be called the South circle. But now heare how Proclus defineth them: *Septentrionalis circulus est is, qui omnium quos perpetuò cernimus, planè maximus est, quique horizontem solo puncto contingit, totus supra terram interceptus; intra hunc quæcunque claudantur astra, nec ortum nec occasum norunt, sed circa polum verti tota nocte cernuntur.* The Arctike circle is the greatest of all those circles which do alwaies appeare, and toucheth the horizont in one only point, and is altogither aboue the earth, and all the starres that bee within this circle, neither rise, neither set, but are seene to runne round about the Pole all the night. The Arctike circle.

Thus haue you the fourth paralel; now resteth the fift, which is thus described by Proclus: *Antarcticus vero circulus æqualis & æquidistans Septentrionali circulo est, & horizonta vno puncto contingens: totus præterea sub terris mersus, intra quem sua astra semper nobis occulta manent.* The Antarctike circle is equal and equidistant to the Arctike circle, and toucheth the horizont in one onely point, and is all vnder ground, and all the starres that be in it, are euermore out of our sight. The Antarctike circle.

These are all the Paralels which are wont to be set forth in the materiall sphere, and that agreeably of all men, saue that touching the two last circles there is a differsnce, of which I will instruct you at large in the next part of our talke, and omitting it for this time, will go forward to other three circles which yet remaine, and are needefull to our sphere. Because our chiefe consideration consisteth about marking of the motions of the Sunne, the moone, and the other planets, how they change their places in the skie, and therefore make diuers apparances to vs that beholde them, and marke their courses, and yet all they haue (as it were) one common path or way, from which they The Zodiake

swarme not, but keepe themselues still within the limites of it: howe thinke you, is not that path of theirs well to be marked, and worthy to haue a notable name?

Scholler.

Mary that is the principall point (as I take it) of all the rest: for without knowledge of that, nothing else can be known.

Maister.

The twelue signes.

That common path of the planets, wherein all they haue their course, is called of Astronomers the Zodiake: which is, as you may English it, the circle of the Signes: which signes are the greatest and notablest partes of that circle, and were inuented for the more exact distinction of the motion of the planets monethly. For as there be but twelue moneths in the yeere, so there are twelue partes of the Zodiake distinct by seuerall names, and correspondent to euery moneth, although they vary something nowe from their first application: whereof hereafter I will instruct you sufficiently, and now will touch them briefly, as this place doth require. Their order in the Zodiake, and their names are these that follow in Latine, which may be englished as I haue vnder-written, and are oftentimes mentioned of our English Poets:

Aries,	*Taurus*,	*Gemini*,	*Cancer*,	*Leo*,	*Virgo*,
the Ramme,	the Bull,	the Twinnes,	the Crab,	the Lion,	the Virgin,
♈	♉	♊	♋	♌	♍

Libra,	*Scorpius*,	*Sagittarius*,	*Capricornus*,	*Aquarius*,	*Pisces*.
the Ballance,	the Scorpion,	the Archer,	the Goate,	the Waterman,	the Fishes.
♎	♏	♐	♑	♒	♓

The degrees of the signes.

And because that their names alwayes can not bee placed in small instruments, there are certaine figures deuised for their names, which I haue also set vnder their names, that you may the better know them. These signes are all of one length, each being the iust twelfe part of the Zodiake. And for exacter knowledge of the motion of the planets euery day, each signe is diuided into thirtie equall parts, which are called Degrees, so that in the whole circuit of the Zodiak there must be 360. degrees, which agree almost with the daies of the yeare.

Scholler.

And thereby I gather, that as the sunne doth moue throughout all the Zodiake in a yeare, so euery moneth he moueth or runneth one signe, and euerie day neere one degree.

Maister.

You gather wel, but this must you marke also, that by this same number of degrees all the circles in the sphere are diuided, so that of euery circle great

or

or leſſe, a degree is the 360. part, and not any meaſure certaine, as a foote, a yard, a mile, or ſuch like. Why a degree is no meaſure.

Scholler.

I vnderſtand you thus: as a quarter is no meaſure certaine, but ſometime is referred to one thing, and ſometime to another, & yet ſtil it betokeneth the fourth part of that whereto it is referred: for when we ſay: a yere and a quarter, an houre and a quarter, a yard and a quarter, a quarter of a foote: in all theſe ſayings, the quarters differ. So when wee ſay, a quarter of corne, a quarter of cloth, a quarter of pepper, a quarter of alume: by the accuſtomed meaſures all men vnderſtand our meaning, and yet theſe quarters differ, and be in common meaning, a quarter of a wey, or eight buſhels, a quarter of a yard, a quarter of a pound, a quarter of a hundreth.

Maiſter.

So is a degree the thirtieth part of a ſigne, and a ſigne the twelfth part of any circle: howbeit, commonly and chiefly the name of Signes is attributed to the Zodiake (which many do call the Thwart circle:) This Zodiake is thus deſcribed of Proclus: *Obliquus circulus is eſt, qui duodecim ſigna continet, ex tribus æquidiſtantibus circulis conſtans: quorum duo latitudinem ſigniferi determinant, tertius per media ſigna ductus vocatur. hic adeo duos pares & æquidiſtantes circulos attingit, Solſtitialem in prima Cancri parte, Bruma-lem in Capricorni principio. Latitudo Signiferi continet partes duodecim. Dictus eſt autem hic circulus Obliquus, quòd æquidiſtantes (ad inæquales angulos) interſecet.* The Thwart circle (or Zodiake) is the circle of the twelue ſignes, and is made of three circles, whereof two are the boundes of his breadth, and the third is called the Middle ſigne circle (becauſe it goeth by the middle of the ſignes in the zodiake) and it toucheth two equall circles of the paralels: that is to ſay, the ſummer Tropicke in the firſt point of the Crabbe called Cancer, and alſo the winter Tropicke in the firſt degree of the Goate called Capricorne. The breadth of the zodiake containeth twelue degrees. This zodiake is called a Thwart circle, becauſe it croſſeth the paralel circles going ouerthwart them. By theſe wordes of Proclus you may vnderſtand, that the Zodiake doth not go directly betweene the two poles of the worlde, as all the fiue paralelles do, but is drawne croſſe the ſphere, ſo that his middle (in breadth) doth The Zodiake.

This whole circle repreſenteth the Zodiake, and the middle circle ſignifieth the ecliptike line.

The Ecliptike line. doth touch the two tropikes, and that middle line is called of Latine Writers, the Ecliptike line, because there can be no eclipse of sunne or moone, vnlesse the moone be vnder that line: as hereafter I wil declare in place conuenient. But touching this zodiake (of which we spake last) I said it was diuided into twelue signes, according to the twelue moneths of the yeare. And because euery quarter of the yeare may bee the more exactly knowen asunder, this Zodiake is parted into foure partes principall, euery part (as it must needes follow) containing three signes.

Scholler.

This is a very apt agreement of Art vnto Nature: for as the whole zodiake agreeth with the whole yeare, so for the foure quarters of the one, there is foure quarters in the other: and for the twelue months of the yere, twelue signes in the zodiake: and for the thirty dayes of the moneth, thirtie degrees in euery signe. But I pray you sir, doth the beginning of these signes answer to the beginning of our yeare?

Maister.

The yere when it beginneth. The beginning of the yeare is diuerse in diuers nations, as I will shewe you another time, with the reason why we beginne our yeare in Ianuary: but for this time it shall be sufficient, to declare the agreement of our yeare with the Astronomers yeare. The Astronomers beginne the twelue signes of the zodiake at Aries, and likewise do they beginne the yeare that day and houre that the sunne entreth into that signe of Aries, which is nowe at the eleuenth

The spring of the yeare. day of March: and from thence they reckon the Spring of the yere three moneths, while the sunne is in the first three signes. Then at the eleuenth day of June, they account the end of the Spring, and the beginning of summer,

The summer. because then the sunne entreth into Cancer, which is the fourth signe, and while the sunne passeth other three signes, (which maketh the second quarter of the zodiake) they account the second quarter of the yeare, which we do call Summer, and that endureth til the fourtenth day of September, at which time the sunne entreth into Libra, where the third quarter of the zodiake doth

Haruest. beginne, and so with it beginneth haruest, which is the third quarter of the yeare, and continueth till the twelft day of December, and then doth the sun

Winter. enter into Capricorne: and winter beginneth, being the fourth and last quarter, which continueth till the eleuenth day of March, where the olde yeere endeth, and a new yeare beginneth.

Scholler.

These foure signes, Aries, Cancer, Libra and Capricorne, seeme to haue a certaine prerogatiue, that they beginne the foure quarters of the yeare, therefore they would be well noted in the zodiake.

Maister.

You say well, and yet they haue other notable qualities, for in the beginning

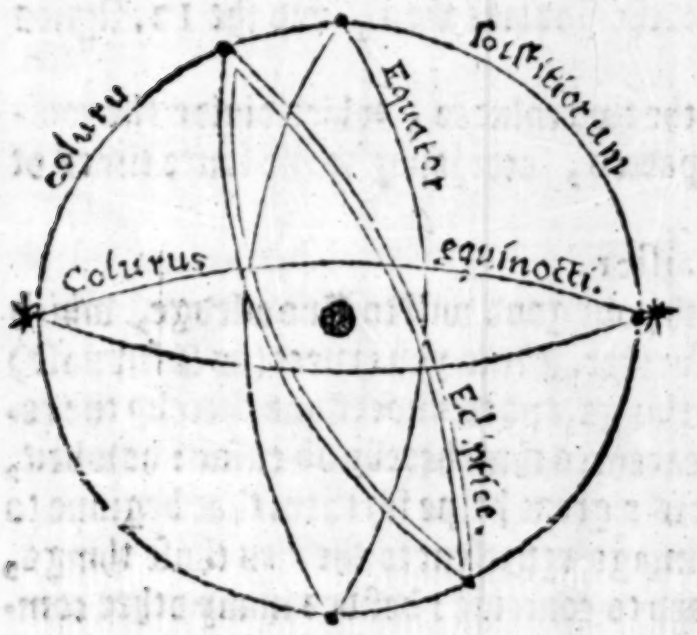
ning of Aries and Libra, the ſunne makes the dayes equall with the nights; and theſe two points are named the Equinoctiall points. In the firſt part of Cancer, the day is at the longeſt, and beginneth to ſhorten by the deſcending of the ſunne from our heads, and when the ſunne doth enter into Capricorne, the day is at the ſhorteſt, and then the ſunne beginneth to returne to vs againe, and the day doth then begin to increaſe. And theſe two points are called the two tropike points. Wherefore as theſe foure points are notable, ſo are there two circles appointed for their limites, the one going by the beginning of Aries and Libra, and the other by the beginning of Cancer and Capricorne: theſe two circles are called Colures, whereof the one only which paſſeth by Cancer and Capricorne, is deſcribed of the Greekes, the reaſon thereof I will ſhew you in the fourth Treatiſe. But this firſt colure, which is called the tropike colure, is thus deſcribed by Proclus: *Sunt & per polos ducti circuli quos nonnulli Coluros vocant: ijs accidit, vt in ambitus ſuos mundi polos recipiant, Coluri autem dicti ſunt, quòd partes aliquas in ſe minime conſpectas habent. reliqui enim circuli in mundi circumactu integri cernuntur, ſed colurorum partes quæpiam quæ videlicet ab * Arctico ſub Horizonte latent, cerni non poſſunt. Signantur autem hi circuli per tropica puncta, diuiduntque per * duas æquas partes circulum qui per media ſigniferi ducitur.*

The Colures.

Tropike Colure.

* Antarctico legendum, contra exemplarium omnium conſenſum.

* Duas admodum apte Linacer tranſtulit loco λ literæ, quam ſemiſsim hic ſignificare, ſupra admonui.



The circles that go by the poles, are thoſe which ſome men call colures: they haue the poles of the world in their circumference. And are named Colures in Greeke, that is, trunked circles, becauſe ſome partes of them come not into our ſight: for the other circles by the turning of the world are all ſeene, but ſome partes of the Colures are not ſeene, that is, thoſe parts which are in the Antarctike circle, and remaine vnder our horizonte. Theſe circles are drawne by the two tropike pointes of the ecliptike circle, and ſo diuide it into 2. equall parts. The equinoctiall colure goeth by the poles of the ſphere, and by the two equinoctiall points of the zodiake, in Aries and Libra. Thus haue you now all the circles needfull for a materiall ſphere: let me heare how you do remember their names.

The equinoctiall colure.

Scholler.

If I ſhould not remember them, I did but leeſe my labour, and occaſion you to ſpend your time in vaine: for I know that in this ſcience and in all o-

A good leſſon.

ther, he that coueteth to runne still forward, and remembreth not that that is gone before, shall neuer attaine that which remaineth behinde, but while hee delighteth too much to see the end, he deceiueth himselfe of the fruitfull ende of knowledge: much like a man that is delighted in hearing a cunning song of musicke, but when it is done, doth remember nothing of it: so is his profit and pleasure both ended, when the song is ended. Therefore (if it please you) I wil repeat the chiefe points that I haue learned since my former repetitiõ.

Maister.

Do so then.

Scholler.

This is it (as I remember)

The second repetition.

1 First, you taught me what a sphere is, and how it is made: also what is his centre, his axe-tree, his diameter, and his poles, and what the poles are named.

2 Next, you declared two circles, that is, the horizonte, and the meridiane circle, which (I perceiue) stand still, and turne not with the worlde, but keepe their places.

3 Then did you describe fiue paralell circles, the equinoctiall, the twoo tropikes, the summer tropike, and the winter tropike, and then the other two paralels, that is, the north circle, and the south.

4 After that you shewed me what the Zodiake was, and the 12. signes that be in him, and of their diuision.

5 And last of all, you described the two colures, which diuide the zodiake into foure equall and principall partes, according to the foure times of the yeare.

Maister.

This good remembrance declareth your good will to Knowledge, which I shall with as good a will help to further. Now you expect (as I suppose) to be instructed in the vse of all these things, and to vnderstand thereby the celestiall motions, and the diuers appearances that thereby do ensue: howbeit, because that a materiall instrument is a great helpe for them that beginne to trauel in this arte, and doth as an image represent to the eies those things, which by only hearing were very hard to conceiue: besides many other commodities, which shall be vttered in their place, I thinke it most conuenient order, first to teach you the maner how to make such a materiall sphere, as may serue both to learne by, and also to worke by, in practising the obseruations needefull to this Arte.

The

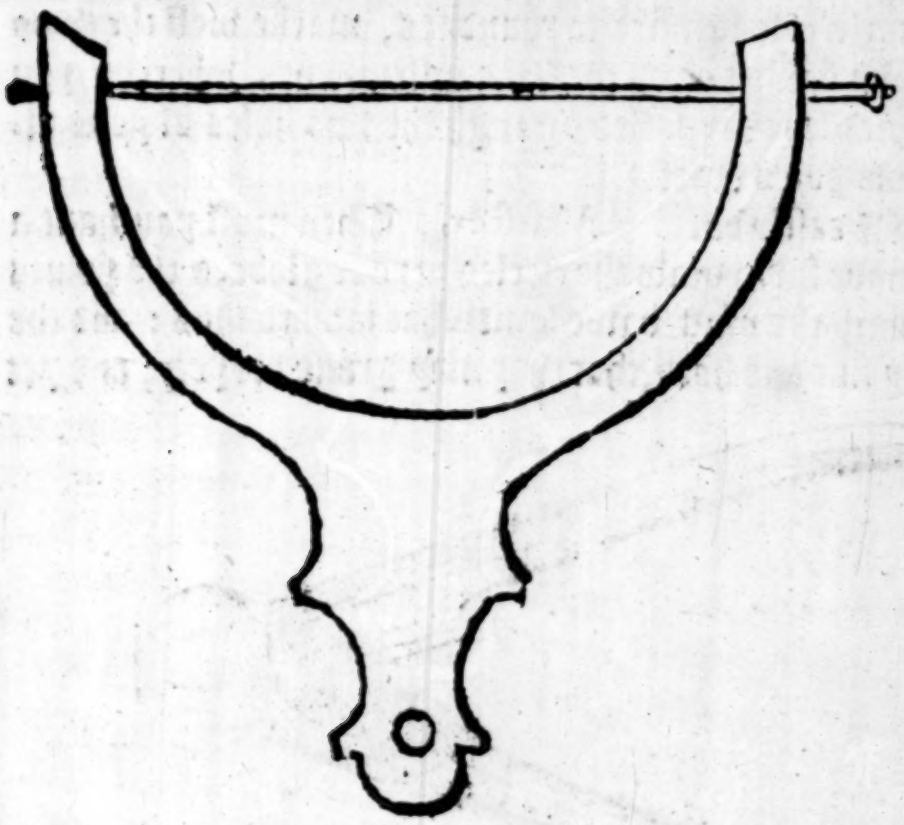
ledge, wherein is taught the making of the materiall sphere, aswel in sound or massie forme, as also in ring forme *with hoopes.*

Maister.

ALthough there be many and woonderfull instruments wittily deuised for practise in Astronomy, as the Astrolabe, the Plaine sphere, the Saphey, the Quadrant of diuers sortes, the Cylynder, Ptolome his rules, Hipparchus rules, Tunsteds rules, the Albion, the Torquete, the Astronomers staffe, the Astronomers ring, the Astronomers ship, & a great number more, which hereafter in time you may know, yet all these are but parts, or (at the most) diuers representations of the sphere: wherefore as the sphere is the ground, and beginner of all other instruments, so is it most meete that we beginne with it, and the rather, because it doth more aptly represent the forme of heauen, then any other instrument can do. What a sphere is, you haue learned before: & how a materiall sphere or globe may be made round, you may coniecture by the same description of Euclide. Therefore must you haue an instrument of steele made like a semicircle, which in the inner circumference must haue a sharpe edge apt to cut and pare smoothe, and (as I may say) by true working to iustifie your globe, which first may be made as round as any Turner can do it: and then shall your instrument not onely duely examine the Turners worke, but correct it exactly, if it be amis.

Instruments of Astronomy.

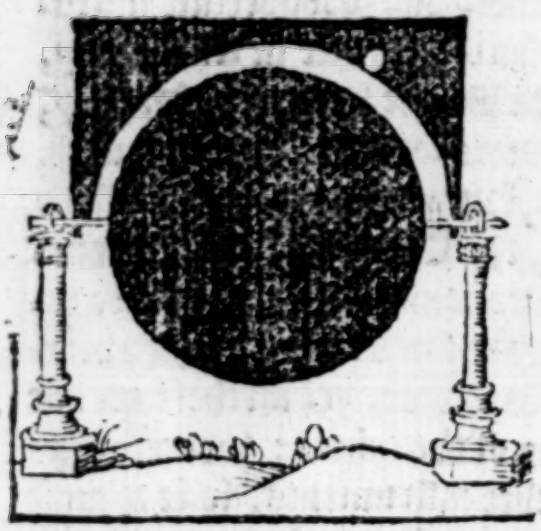
The turning of a globe.



This is the forme of that instrument, & it is thus made iustly first draw a right line as long as you will haue the diameter of your sphere, and an inch

inch longer, or more. Then open your compas according to the halfe diameter of the sphere that you would make, and draw halfe a circle, so that the fixed foote of your compas be set in the middle (as you may nearely gesse) of the said line, and with the other moueable foote make the semicircle, but not fully complete to the diameter, for there must be 2. holes made as big as a wheate strawe, or bigger, according to the bignes of the globe, and thorow these holes must the Turners spindles pierse that must beare the globe while it is in turning: but you must take good heede, that those holes be so made, that the foresaide line do passe exactly thorow the very middle of them, for so much as you misse in making those holes, so much will your sphere be false in euery quarter. Againe, you must take heed that your instrument do not bow inwarde without those holes toward both ỳ points, except it be in true compasse, but better it is to syle it somewhat aslope outwardly. What more is to be done, I leaue it to the studious deuise of your owne practise: for such things are better taught by hand, then by mouth.

An other forme of the same worke.



Scholler.

I would I could as well vse it, as I could deuise to make it iust round.

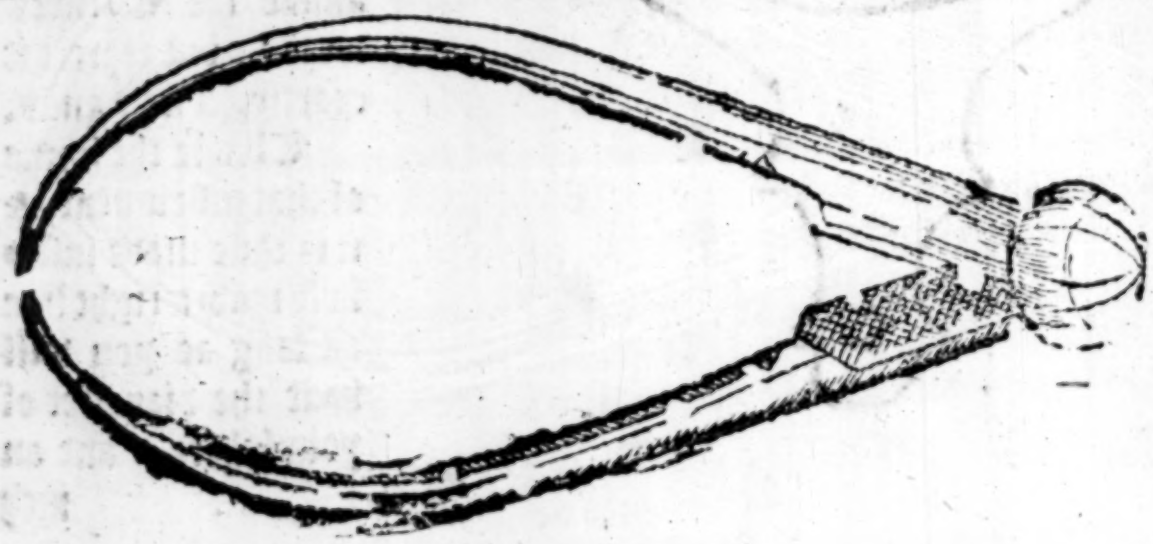
Maister.

To find the poles in a globe.

When you haue your globe so iustified in roundnes, marke well the two poles of it, which you may easily doe by the same instrument, whereby you did iustifie it, for the spindles that passed thorough the two holes of your instrument do touch the two poles exactly.

Scholler. That can I easily do. Maister. Then must you haue a paire of compas aptly made for to draw the circles in your globe, & the points of the shankes in that compasse must bowe somewhat inward thus: and the points of it must be very fine and hard, that they may graue deepely, and yet

A compas for a globe.



make

make a fine and ſmall circle: for, the finer that your circles be, the exactlier will the diuiſions be made, and the leſſe errour will be in the making and vſing of the ſame globe. Then ſet one foote of the compas in one of the poles of the globe, and open the other ſo wide, as you thinke will ſuffiſe to reach to the middle of the globe, toward the other pole, and with that foote make a light marke in the globe: and keeping your compas vnchanged, put one foot of it in the contrary pole, and turne the other foot toward the foreſaid marke, in the middle of the globe, and if the foote touch it exactly, then is that middle duely found: but if the compaſſe reach too farre, or too ſhort, make with it another light marke, and the true middle betweene thoſe two markes is the iuſt middle of the globe or ſphere, as by your compas a little opened more or cloſed (as you ſee cauſe) you may prooue.

Scholler.

That can I do well inough, by experience learned in often practiſing the conclusions of your Pathway. The pathway.

Maiſter.

That Pathway will leade you rightly to this worke, if it be well trauelled as it ought to be before you come to this worke. But to proceede with our ſphere: When you haue found the iuſt middle of the Globe betweene both the Poles, then open your compaſſe according to the diſtance of that middle marke, and one of the poles, and ſet one foote of the compaſſe in the Pole (which you liſt) and with the other draw a circle rounde about the globe. Which whether it be truely done or not, thus may you prooue: Remoue the foote of your compaſſe into the other Pole, and with the mooueable foot trie the former circle, and if the compaſſe runne iuſtly in it, then is that circle truely drawne betweene both the poles, elſe haue you erred: and therefore graue not the circle too deepe, till you haue examined it. And when you haue found it true, then without altering of the compaſſe, ſet both feet of it in the ſaid circle, and they will take the fourth part of the ſame circle, as by remouing it foure times you may know. Proofe. The dirtding of the equinoctiall.

Scholler.

That haue I learned in the Pathway alſo, & if I haue miſſed, it is by the groſſeneſſe of the pointes of my compaſſe, or elſe by mine owne groſſe negligence, which both I can quickly examine and amend, as the caſe requireth.

Maiſter.

After that you haue marked out thoſe foure partes of that circle, diuide eche of them into three euen partes, and ſo haue you that circle diuided into twelue equall partes: marke thoſe partes with little croſſe lines, or els draw an other circle within a corne breadth of that other, on which ſide you liſt, but let it be ſomewhat leſſe graued then the firſt, that the firſt may be known for the true circle, and this ſecond circle to ſerue but only for the markes of di-

uision in that other: and so draw a line at euery 12. part, from the one circle to the other. Then diuide euery one of those partes into three lesser partes, and eche of them againe into euen halues, and so haue you in all, 72. partes made of that circle. After this, diuide one of those partes into fiue lesser portions, equally, and by the same example diuide all the other 71. partes, and so haue you in the whole circle, 360. partes, which you shall marke with numbers of figures, from 10, to 10, beginning where you list.

Scholler.

Those 3 may call degrees, as I remember by your former lessons: and I must marke them thus. 10. 20. 30. 40. and so vnto 360.

Maister.

So it is: And this circle thus drawne in the middle betweene both the Poles, is the Equinoctial circle in that sphere. Now to make the two tropikes, open your compasse so, that they may extend to 66. degrees and an halfe of the said equinoctial circle: and then set one foote of the compasse in which pole you wil, and with the other foot draw a circle on the globe, which shal stand for one of the Tropikes, and setting ẏ foot of the same compasse vnaltered, in the other pole, draw about it an other circle, for the other tropike. Now appoint names for the poles, calling one the South pole or Antarctik pole, and the other the North-pole or Arctike-pole: and then the tropikes of necessitie wil take their names: for that Tropike which is next the North-pole, must be the tropicke of Cancer, that is the Summer tropike, and the other that is next to the south-pole, must needs be the tropike of Capricorne, or the Winter Tropike. Then marke where you began the numbring of the degrees in the Equinoctial (which may wel be called the beginning of the Equinoctial) and set one foote of your compasse in that beginning, opening the other foote til it will reach vntil 90. degrees iustly, and first hold the one foote steadie in the beginning of the Equinoctial, and draw a circle with the other foot, and if that circle touch both the poles of the globe, then is it truely drawne. But it should go also by the end of the 270. degree of the Equinoctiall, and if it misse anie whit, examine it wel, and amend the fault, before you worke any further. Which rule you shal obserue stil, for els of one fault neglected many other may ensue.

To draw the two tropikes.

The poles.

The tropikes.

The tropike Colures.

Proofe.

A general rule

This done, keepe your compasse at the same wideneſſe, and set one foot in the Equinoctial circle, at the end of ninetie degrees, and holding it steadie, with the other foot describe a circle, which shal passe by both the poles of the globe, and by two pointes of the Equinoctial, that is the beginning of it, and the end of 180. degrees: and if you haue missed, amend it by and by. This last circle is the Colure Equinoctial, and the other last before drawn is the Colure Tropikall, or Solstitial, or the tropike Colure. These two circles shal you diuide into 360. partes ech of them, beginning your numbring at the Equinoctial,

The Equinoctial Colure.

Proofe.

The diuision of the Colures.

quinoctial, and reckoning toward the Pole, in euerie quarter of them ſeuerally, ſo ſhal you neuer reckon aboue 90. But it is eaſily knowne, that foure times 90. doth make 360.

Scholler.

But in this order of numbering, the common form of accompt is not kept as it was in the Equinoctial: for when I haue reckoned in one quarter 90. degrees from the Equinoctial to the Pole, then if I go forward in the ſame circle, the next number beyond the pole is 90. againe, & ſo that ſecond quarter decreaſeth from 90. to 10. going backward, and thē the third quarter increaſeth from 10. to 90. and the fourth quarter decreaſeth againe from 90. to 10.

Maiſter.

So muſt it be in theſe circles for moſt aptneſſe in accompt, as you ſhall perceiue hereafter. Now ſhall it be conuenient to marke in what degrees the two tropikes doe cut thoſe Colures: for if you haue not erred, they touch the middle of the 24. degree in euery quarter of the Colures. And if you haue done wel, then proceed to the making of the Zodiake, which you ſhall draw thus. Open your compaſſe to the ſame wideneſſe that you did for making the Colures, or the Equinoctial, and then reckon from one of the poles (which you wil) 23. degrees and an half, in any one of the Colures, & it wil light in 66. degrees and an half, becauſe the numbers from the pole-ward go backward (as you confeſſed before) then with a leſſer compaſſe (for it ſhalbe meete that you haue diuers ſortes) drawe a circle of that circuite about eche pole, ſetting the fixed foot of the compaſſe in the pole, and ſtretching the other foot vnto 66. degrees and a halfe. After this looke whether theſe circles doe cut like degrees in euery quarter of the Colures: and if they doe, your worke is right, els it muſt be reformed. Theſe circles may wel be called pole circles, or Polar circles. Then take your greater cōpaſſe opened (as is before declared) to the wideneſſe of a quarter of the equinoctial, and ſet one foote of them in that point where the Polare circle that is about the North-pole, doth croſſe the tropike Colure in that quarter, which goeth from that ſame pole to the 270. degree of the equinoctial, and holding that foote ſteadie, with the other draw a circle about the globe. This circle wil touch the two tropikes in two of thoſe places, where they croſſe the tropike colures: and alſo it wil croſſe the equinoctial in two pointes, that is, in his very beginning, and in the end of the 180. degree. Now to proue whither it be truly drawn or not, by an other meanes, ſet one foot of that compaſſe (with which you drew the Zodiake) in that point which is directly contrary to the firſt place, where you ſtaied it: that is to ſay, in the croſſing of the South Polare circle, and that quarter of the tropike Colure, which goeth from the South pole to the 90. degree of the equinoctial, & on that point proue whether ỹ moueable

Proofe.

Pole circle.

The drawing of the Zodiak

Proofe.

Another proof

foot

foot of the compasse will exactly agree with the foresaid circle, which if he doe, it is wel drawne, els is there some errour, which must be amended. This circle thus drawne, is the Ecliptike circle, which goeth by the middle of the Signes and of the Zodiacke, and these two pointes wherein the fixed foote of the compasse was staied, are the poles of the Zodiake. But considering that the Zodiake (as you heard before) hath in it twelue degrees of bredth: that is, on eche side of the Ecliptike line fiue, therefore open your compasse to 84. degrees only, that is fiue degrees lesse then a quarter of the equinoctial, and set one foot of it firedly in the one pole of the Zodiak, and with the other moueable foot draw a circle, which will be a Paralelle to the Ecliptike circle, distant from it in al partes by fiue degrees: and with the same compasse vnaltered, draw a like circle on the other pole of the Zodiake, which shalbe a Parelelle to the other two, and they three doe make the ful zodiake in length and bredth.

The poles of the Zodiake.

Scholler.

I vndestand al this very wel, but I muse what those Polare circles mean, of which I heard no word before in the first treatise.

The Polare circles and, their vse.

Maister.

I did of purpose omit them before, because they are named of diuers men, as of *Ioannes de Sacro Bosco* and other later writers, for the circles Arctike and Antarctik, contrary to Proclus, and al the Greeke writers: and I purposed (and so I doe stil) to reserue the discussing of that repugnance, to the 4. treatise, yet here was such iust occasion ministred to vse their helpe in finding the poles of the zodiake, by which poles they are described euery day, by the reuolution of the heauens, that I could not willingly neglect them: for although I might finde the poles of the zodiacke without them, yet they bring a proofe of the worke with them, as before I haue shewed, and also they enclose al such starres as are within 23. degrees and a half of the pole, and are the limites of the motion that the poles of the zodiake doe make about the poles of the world, as you shal better perceiue hereafter. And because their names should not be confounded with the circles, Arctike and Antarctike, I thinke it most meete to call them onely Polare circles, or pole circles, which name the other circles may not iustly chalenge, especially because they are not fixed (as the pole circles are) but be changeable as the regions change. Which thing I wil declare more largely hereafter: but nowe for the drawing of the circles Arctike & Antarctike, that is (as I named them) the North circle, and the South circle, you must learne the elenation of the region for which the globe is made, and according to it must you draw those circles, which thing because as yet it is not easie for you to doe, I wil in example of our owne countrey shewe their description, namely for the Uniuersitie of Cambridge, which standeth in euen degrees of 52. Therefore reckon from one of the

Circles arctike and antarctik.

Poles

Poles 52. degrees in any Colure, and it wil light on 38. degrees (because the numbers go backward) and there ſet one foot of your cõpaſſe extending the other foot to the next pole, where you ſhal ſtay it, and with the other foote deſcribe a circle firſt about the one pole, and then about the other: and thoſe two circles ſhal ſtand for your circles Arctik and Antarctike. And thus hath the Globe al thoſe circles which were accompted needful vnto it, except the Horizonte and the Meridian circle, which are not ſo well placed in the globe as without it, becauſe they ought not to mooue with the Globe.

Scholler.

Where ſhal they be made then?

Maiſter.

That wil I ſhew you, as ſoone as I haue ended the Globe, which yet is not done, for the Signes in the Zodiake are yet vndrawne. Firſt therfore ye ſhal drawe by the Ecliptike line, within a corne bredth of it, another circle as you did by the equinoctial, it forceth not on which ſide, but let the Ecliptike line be more notable then it. Then conſider that the zodiake is alreadye diuided into foure equall quarters by the two Colures: now it is meet to diuide euery quarter into three equall partes, and ſo haue you twelue partes in the whole zodiake, which ſtand for the twelue Signes, which ſhalbe diſtinct by lines drawne ouerthwarte all the bredth of the zodiake. The diuiſion of the zodiake.

Scholler.

Thoſe are not eaſie to draw, but errour may quickly be committed, in making them wider in one place then in another.

Maiſter.

Therfore to auoid that errour, thus ſhal you doe. Open your compaſſe equally with a quarter of the zodiake. Then keep one foot of it ſteady in eche diuiſion, one after another, and with the other draw a portion of a circle croſſe ouerthwart al the bredth of the zodiake, and thus you ſhal doe it exactly: and in ſo doing, your compaſſe doth trie and examine the former diuiſion: for if at any ſetting of your compaſſe it reach too ſhort, or too far, and not iuſtly on the third ſigne, then muſt you correct your firſt diuiſion. When you haue drawne theſe twelue ſignes, then muſt you diuide euerie one of them firſt into two partes equally, and eche of them againe into three euen partes, and laſtly, euery one of them into fiue iuſt portions: and ſo haue you in euery ſign, thirtie partes or degrees. Brooks.

Scholler.

This diuiſion is like the diuiding of the equinoctiall and the Colures, ſo that I may conceiue the one by the other.

Maiſter.

Indeed they are al three like in their general diuiſion, but yet in placing of their numbers, they differ eche from other, for the equinoctial had his num-

bers continually proceeding from 1. to 360. The Colures, stay their numbers at euery quarter, neuer proceeding aboue 90. but the zodiake staieth in a lesser number, for at euery signe, his numbers chaunge: so that from the beginning of eche signe to the end of the same, you shal marke them from 10. to 10. thus: 10. 20. 30. and so like in al the zodiake no number is greater then 30.

Scholler.

I perceiue that, sith you told me before, that euery signe seuerally hath 30. degrees.

Maister.

Those diuisions shal you marke with a little line drawne from the Ecliptike circle to that other which is drawne within a corne breath of it: yet at euery ten degrees it will doe well to draw the line somewhat longer from the Ecliptike, that those degrees may be the easier to see and to reckon: and so may you doe at euerie fiue degrees, but somewhat shorter then that other, and so shal you haue the degrees more notably distinct in sunder. Nowe resteth no more but to giue euery signe his name, which you may do either by writing it at length, or els by setting their Characters and figures for their names, which I before haue set forth vnto you in both formes.

Scholler.

That is easie enough to vnderstand, but how shall I know their places?

Maister.

That is as easie also, if you marke the order of the circles: but for a full plainnesse you may begin at the tropike of Cancer, where the signe of Cancer doth begin, and in that quarter of the zodiake, which is on your right hand, and descendeth toward the Equinoctiall, set these three signes, Cancer, Leo, Virgo, and so proceed forward as the signes succeed in order: then will the second quarter haue Libra, Scorpius, and Sagitarius: and the third quarter, Capricornus, Aquarius and Pisces: and to make vp the fourth quarter, there resteth Aries, Taurus and Gemini.

Scholler.

You name the second quarter of the zodiake to be the first, and so commeth it to passe, that you call the first quarter the fourth, as I remember your former doctrine.

Maister.

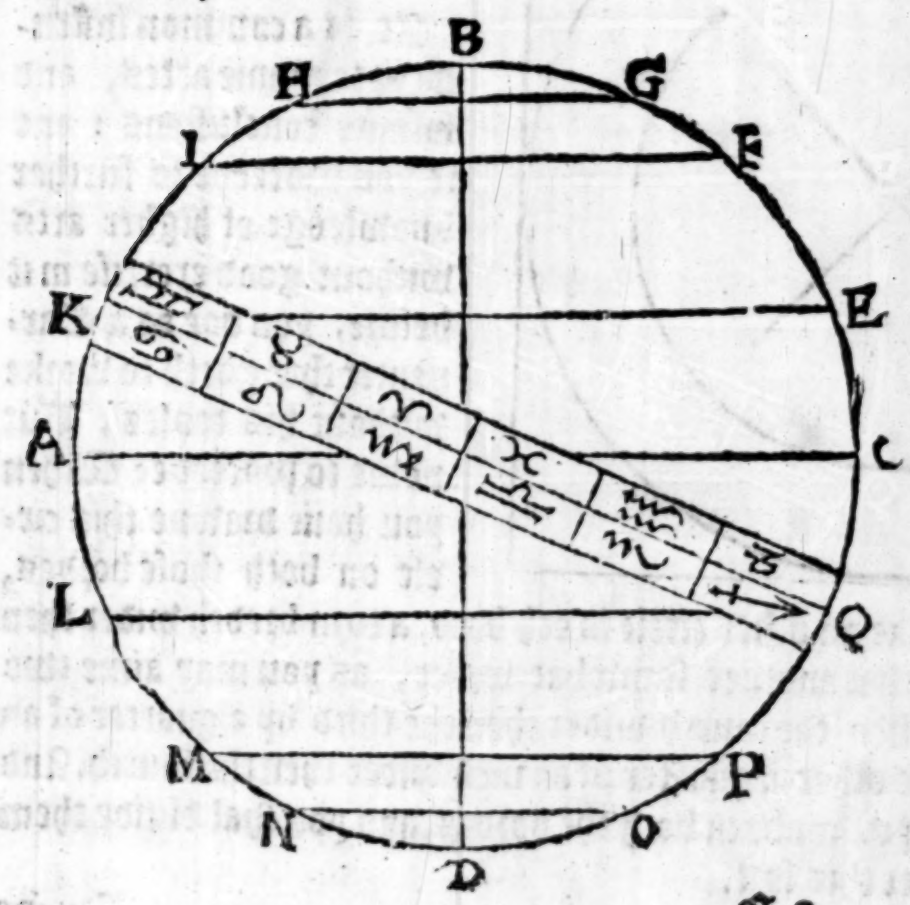
You may perceiue, that I named them now not in their customable order of quarters, but according to the order of this worke: els if you can discerne the place of Aries from the place of Libra, you may best begin with Aries, & then not only the signes, but the quarters will keep their accustomed order, as here in a table it doth appeare: where I haue also annexed the quarters of the yeare for readinesse of remembrance, and for the better occasion to marke the motion of the sunne in eche of those quartes.

And

quarters of the zodiake	The quarters of the yere.	The ſignes in euery quarter of the zodiake, anſwering to ech quarter of the yeare.		
1.	Spring.	Aries,	Taurus,	Gemini.
2	Sommer.	Cancer,	Leo,	Virgo.
3.	Haruelt	Libra,	Scorpius,	Sagitrarius.
4.	Winter.	Capricornus,	Aquarius,	Piſces.

And thus haue we ended the globe or ſphere, with all the circles in it cuſtomably vſed, whoſe picture here you may ſee, as it wil be drawn in flat form.

A C. is the equinoctial circle.
E.K. the tropike of Cancer.
Q.L. the tropike of Capricorne.
Q.K. the zodiake.
B, and D, the 2. Poles of the worlde.
F,I. the Arctike circle.
P,M. the Antarctike circle.
G,H, and O, N. the two Polare circles.
G, and N, the 2. Poles of the zodiake.



The making of the Horizonte.

Nowe for the Horizont and the Meridian thus ſhal you do. Take two ſquare boordes of a quarter of an inch thick, & let ỹ one be in breedth 3. inches, and the other one inch & a halfe more then the diameter of your globe: in the middle of the broader boord take a centre, and on that centre make a circle, ſcarſly a corn breedth wider then your globe is, which you ſhall thus finde out. Open your compaſſe as wide as 2. ſignes in the Zodiak, or 60. degrees in the equinoctiall, or any other of his great circles, & that compaſſe will make a circle iuſt in bigneſſe with any great circle of your globe, therefore make you the circle in ỹ ſquare boord, al-

corne bredth wider then that circle of your globe. And without altering of the compasse, make the like circle on the middle point of the narrower bord. Then haue you taken the iust measure for the inner part of your Horizont, and also of your Meridian.

Scholler.

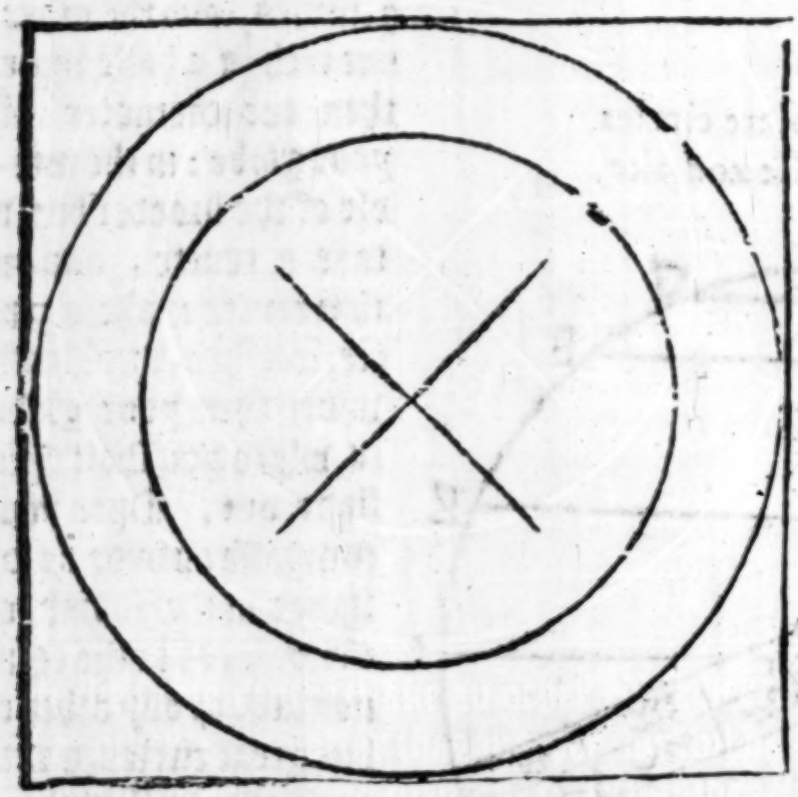
I doubt not but I can doe that with a little labour by often trial where the middle of the boord is: but is there no way to finde the place of the centre quickly?

Maister.

To finde the middle in any square.

Yes truely, and that may you doe diuerslie, but one ready way is this. Draw with your ruler a right line frō corner to corner, or if you list, make it only about the middle of the bord, as you can aime with your eye, but bee sure that you drawe it long enough, then turne your ruler to the other two corners, and make a line crosse that other, and where they doe crosse, there is the middle of the bord, on which, as on a centre you may make your circles. This worke might you easily gather out of the 35. conclusion of the Pathway.

The Pathway of Geometry.



Scholler.

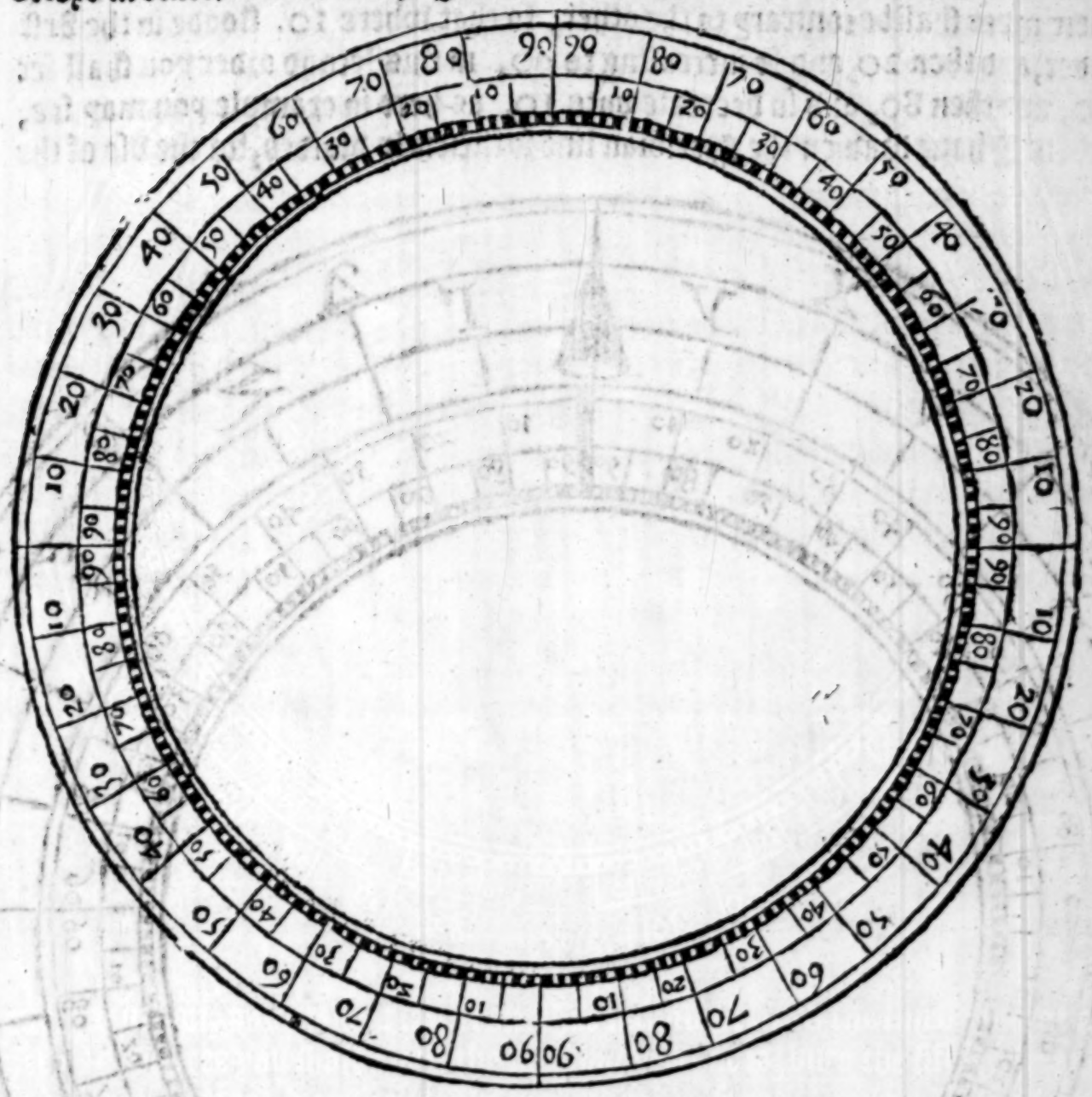
I see nowe continually more and more, that the Pathway serueth to other vses, then I tooke it.

Maister.

It is a common instrument to manie artes, and infinite conclusions: and if you proceede to further knowledge of higher arts without good exercise in it before, you doe as a Carpenter that goeth to worke without his tooles. But nowe to proceede: When you haue drawne this circle on both those bordes, on the same centre make an other circle in ech bord, a corn bredth wider then that other: and after that another somwhat wider, as you may aime two corne bredthes: and then the fourth wider then the third by a quarter of an inche: and yet agam one other, a quarter of an inch wider then the fourth. And these fiue circles shall you make in both the bordes, and you shal diuide them both in one maner, after this sort.

Diuide

Diuide the innermoſt circle ſaue one into foure quarters firſt, and after that, euery quarter into three partes, & ech of thoſe parts into 30, as you did before in diuers circles of the globe: then ſet your ruler to the centre, and to



euery diuiſion, and make a line from that ſecond circle to the third: but at euery 10. degree you ſhall draw the line longer, that is, vnto the fift circle, and at euery fift degree, you ſhall draw the line to the fourth circle, ſo ſhall you both place your numbers beſt, and alſo reckon them moſt ſurely, and moſt ſpeedily in all vſes of them.

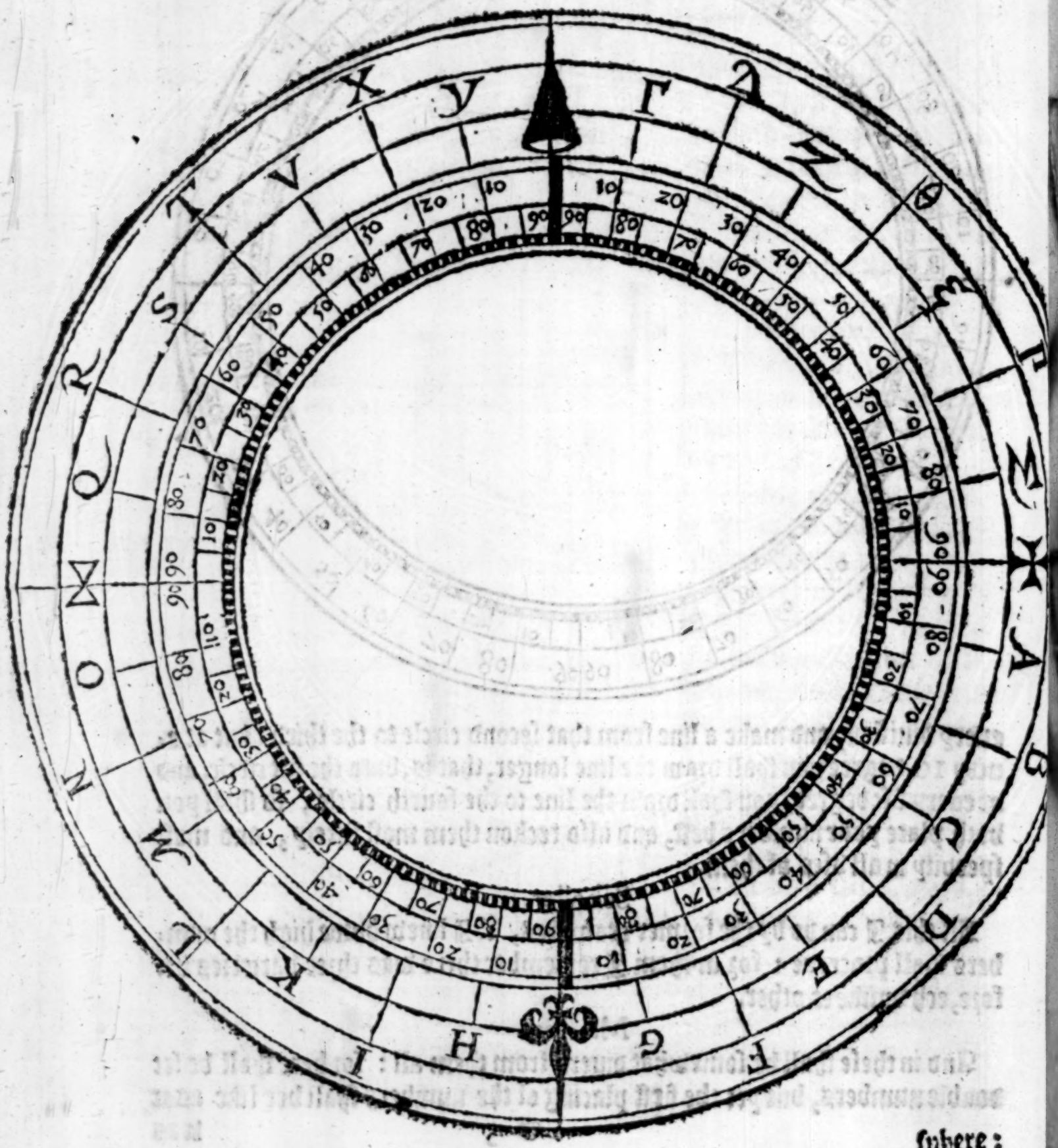
Scholler.

All this I can do by the former examples, if I knew howe high the numbers ſhall proceede: for in them I remember there was three varieties before, ech vnlike to other.

Maiſter.

And in theſe ſhall be somewhat diuers from them all: for here ſhall be ſet double numbers, but yet the firſt placing of the numbers ſhall bee like as it

was in the colures, I meane in ech quarter 90. and thsse numbers shall bee set in the space, betweene the third circle and the fourth. Then shall you set the like number betwene the fourth circle and the fift, but not in like order, for their order shallbe contrary to the other, so that where 10. stoode in the first order, and then 20, and so increasing to 90, in this second order you shall set 90, and then 80, and so decrease vnto 10, as here in example you may see, where I haue drawen the Meridian line sufficiently diuided, for the vse of the



sphere:

ſphere: but then the horizont muſt haue other things drawne in it, as in the figure next aforegoing you may ſee: for in the inner part it is diuided like to the meridian, but then without thoſe diuiſions it hath a certaine ſmall ſpace all blacke left for a partition, without which there are drawen three other circles, eche one alittle wider then other, and the wideſt is vttermoſt, and the laſt circle is as large as the boorde will permit, ſo that the whole breadth of the horizont is an inch and a halfe, forbecauſe the whole boord was three inches wider then the globe. And the Meridian ſhall be but three quarters of an inch broade, ſeeing his boord was but one inch and an halfe wider then the globe. Now for the diuiſion of the vtter part of the horizont, you ſhall diuide the vtteryoſt of the three circles into eight partes onely: the ſecond circle ſhall be diuided into 16. partes, and the third or innermoſt of thoſe three, ſhalbe parted into 32. partes, which do betoken the points of the ſhipmans compas, or the 32. windes notable in ſayling, as ſome men liſt to call them. If your horizont be large enough to receiue their names, you ſhall write them at length, elſe may you write letters for them, as your owne fantaſie pleaſeth. Their names are theſe following, agreeable to thoſe places and letters, which I haue drawen in the horizont.

The names of the thirtie and two points in the ſhip compaſſe, which be the windes names, that Mariners ſaile by.

✠	North.	N	Eaſt northeaſt.
♁	South.	O	Eaſt and by north.
X	Eaſt.	Q	Eaſt and by ſouth.
✠	Weſt.	R	Eaſt ſoutheaſt.
A	Weſt and by north.	S	Southeaſt and by eaſt.
B	Weſt northweſt.	T	Southeaſt.
C	Northweſt and by weſt.	V	Southeaſt and by ſouth.
D	Northweſt.	X	South ſoutheaſt.
E	Northweſt and by north.	y	South and by eaſt.
F	North northweſt.	r	South and by weſt.
G	North and by weſt.	▵	South ſouthweſt.
H	North and by eaſt.	Z	Southweſt and by ſouth.
I	North northeaſt.	⊖	Southweſt.
K	Northeaſt and by north.	ξ	Southweſt and by weſt.
L	Northeaſt.	Γ	Weſt ſouthweſt.
M	North and by eaſt.	Σ	Weſt and by ſouth.

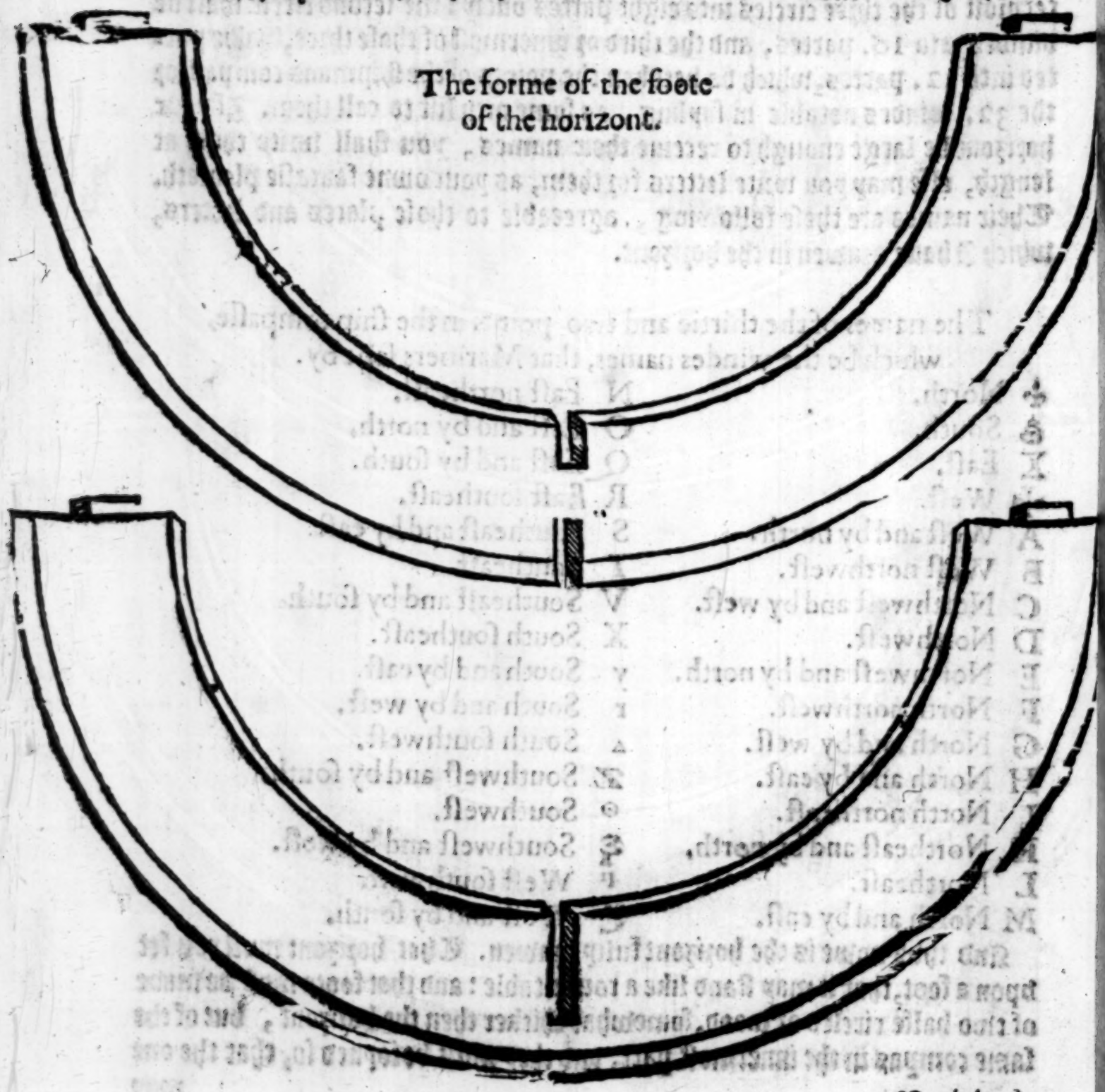
And thus nowe is the horizont fully drawen. That horizont muſt you ſet vpon a foot, that it may ſtand like a round table: and that foote muſt be made of two halfe circles of wood, ſomewhat thicker then the horizont, but of the ſame compas in the innermoſt part, and they muſt be ioyned ſo, that the one

may

may crosse the other with right corners, & themselues be fastned on a strong foot, that may beare all the whole frame, with the globe. The ioyning of thē to the horizont is diuerslie to be imagined, for if their heads be flat, then must you haue nailes or pins, that must pierse the horizont & enter into their heads, otherwise there may be left certaine tenants on their heads, & then must you make like mortaises agreeable to them, in the horizont, to receiue those tenants: and so may there be imagined diuers other formes, which I leaue to your owne deuise.

Schol. If I might see their forme, I should be much eased in framing it.

Maister. Here is the forme, with their sockets, and one namely for the

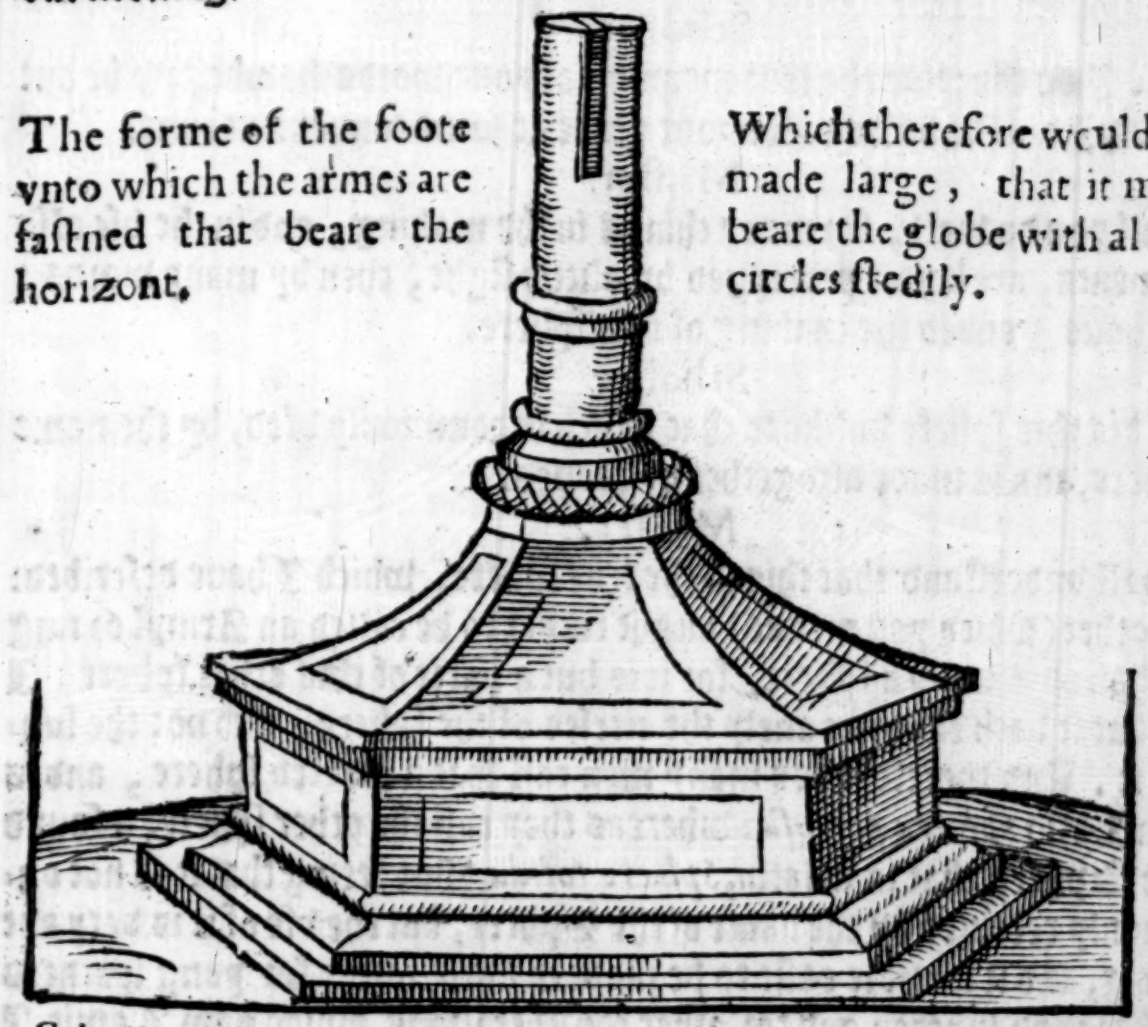


The forme of the foote of the horizont.

Meridian,

Meridian, in that arme also that goeth from east to west. Howbeit, it shall be best to fasten those armes vnder the horizont in the southest, southwest, northeast and northwest, and so shal the Meridian sincke best into the horizont, with an easie socket in the meeting of those armes, so that the iust halfe of the meridian onely may appeare aboue the ouer edge of the horizont: in which thing practise shall instruct you further. As for the foote, make it as you thinke best. But now must you cut out of both, the meridian and the horizont al that is within the innermost circle, and so must you pare away all that is without the vttermost circle, to make them both like iust circles. Also you must make in the horizont two sockets, one by the south line, and the other by the north line, so that the one side of those sockets which is toward the east, shall touch the south and north lines, and the other side shall goe westward from both those lines, as much as the thickenesse of the meridian is: and the length of ech of those sockets shall be agreeable to the iust breadth of the meridian, so that the meridian may enter iust into those sockets, and turne in them without stressing.

The forme of the foote vnto which the armes are fastned that beare the horizont.



Which therefore would be made large, that it may beare the globe with al his circles stedily.

Scholler. This troubleth me somewhat, because the sockets be not iustly one against the other, but both stand toward the west halfe of the horizont.

Maist. It would trouble you worse to remember that the globe must be fastned to the meridian on the 2. poles, & both they placed within ỹ horizont.

Scholler. That is strange indeed, for so should the globe beare more to-

ward the west, then toward the east: and so all were missframed.

Maister.

The hanging of the globe in the meridian.

To auoyde all that, you shall make two small clampes of thinne brasse plate, and bow them so in the middle, that when they are tacked to the side of the meridian in two contrary points, iust ouer that line where ♋ ♑ is set, they may receiue in their bout the poles of the globe. I meane here by the poles two short pinnes, which shall go through those clamps of brasse, and be fastned or driuen into the two poles of the globe, except you will take the paine to pierse a hole through the globe, from one pole to the other, for so may you make an axetree to runne thorow both the clamps and the whole globe, which is all to one effect. And by this meanes shall the globe not onely hang in the iust middle of the horizont, but also the one side of the meridian (which hath the diuisions in it) shal point exactly the south and north parts of your globe, which wil be most exactly seene, if you consider the thicknes of your axe-tree, and frame your clampes so, that the one halfe of the thicknesse of the axe-tree may be set into the side of the meridian.

Scholler.

I thinke I do conceiue the true meaning of your words: howbeit, to be out of all doubt, I will be bolde to see your globe at some conuenient time.

Maister.

So shall you do well, for many things in the making, and in the vse also of instruments, are better perceyued by a little sight, then by many words: and thus haue I ended the making of this sphere.

Scholler.

And yet is this sphere vnlike to that which is commonly vsed, by the name of the sphere, and is made altogether of hoopes.

Maister.

The Armill or Ring sphere.

You shall vnderstand that this is the true sphere, which I haue described: and that other (which you meane) ought rather to be called an Armyl or ring sphere, than absolutely a sphere, for it is but a parte of this other sphere: I meane, that it doth containe onely the circles of the sphere, and not the substance of it. And therefore dos many men call that a Persed sphere, and is named in Latin *Sphæra pertusa*: whereas they call the other sphere, a sound or massie Sphere, that is in latin, *Sphæra solida*. But seeing that it is not only commonly receiued by the name of the Sphere, but the vse of it is very apt in teaching, and it is more easie to be made in slight forme for yong learners then is the sound sphere: and for other considerations, which now I omit, I will also describe the composition of that Armyl sphere. First you shal make of wood or of brasse (as you list to bestow the cost) foure hoopes of one bignesse in compasse, the one of them being three times so broad as any of the other, as your eie may aime. Then diuide ech of those circles into 360 parts,

The making of the Ring sphere.

and

one of them, according as you did diuide the equinoctial in the former ſphere, and the other two like vnto the two colures, and the fourth which muſt be the broadeſt of them, you ſhal diuide, as you learned to diuide the zodiake in the other ſphere. And when they are thus diuided, you ſhall call them by the names of thoſe circles whoſe diuiſion they follow: wherefore if the zodiake haue more breadth then 12 degrees are in length, you ſhall abate the ouerplus, allowing it but 6. degrees in breadth on ech ſide of the ecliptike line, which as you remember before, did runne by the middle of the zodiake.

The equinoctiall. Two colures. The zodiake.

Scholler.

Then I perceiue I muſt make in this zodiake an ecliptike line, and all the ſignes with their diuiſions, as I learned in the other zodiake.

Maiſter.

You ſhal make them as like as you can deuiſe. Then ſhal you ioyne the 2. colures ſo together, that the one of them may croſſe the other (as they doe in the globe) with right & equal corners, obſeruing wel that the places of their croſſing be in the iuſt points where 90 is ſet, in ech of them: and thoſe places muſt be called the Poles of the ſphere. Then put on them both croſſewiſe (like a girdle) the equinoctiall circle, ſo that it doe croſſe them exactly with his middle, in thoſe points where the number of ech quarter doth begin, and that the beginning of the equinoctiall in number be againſt the iuſt middle of one of them, that is, of it that ſtandeth for the equinoctiall colure, and then ſhal the 180 degree of the ſame equinoctiall ſtand iuſtly on the middle of the ſame colure, in the contrary point: and the other colure, which is the tropike colure, ſhal be ioyned with the 90 degree, and the 270 of the equinoctial, in two contrary points. Then ſhall the 2. tropike circles be ſet on the colures equidiſtantly to the equinoctial, ſo that they be faſtned on the 23 degree and a half from the equinoctial: whereby you may eaſily conceiue, that they muſt be ſomewhat leſſer then the equinoctial, that they may ioyne cloſely to the colures. Then muſt you haue two other circles of one bigneſſe, that may ioyne iuſtly with the colures, 52 degrees from the equinoctial, on ech part equally diſtant: and thoſe muſt be called the Arctike, and Antarctike circles, or the ſouth circle, and the north circle. Beſide theſe, you ſhal make two other leſſer circles of equal bigneſſe, which ſhal be ſet on the colures alſo equidiſtant from the other paralels: and they muſt be faſtened with their middle on the 66. degree and a halfe from the equinoctial on both ſides, that is, 23 degrees and a halfe from ech pole: and therefore I thinke meeteſt to call theſe circles peculiarly, Pole circles. This being done, you haue two colures, and ſeuen paralels fixed on them.

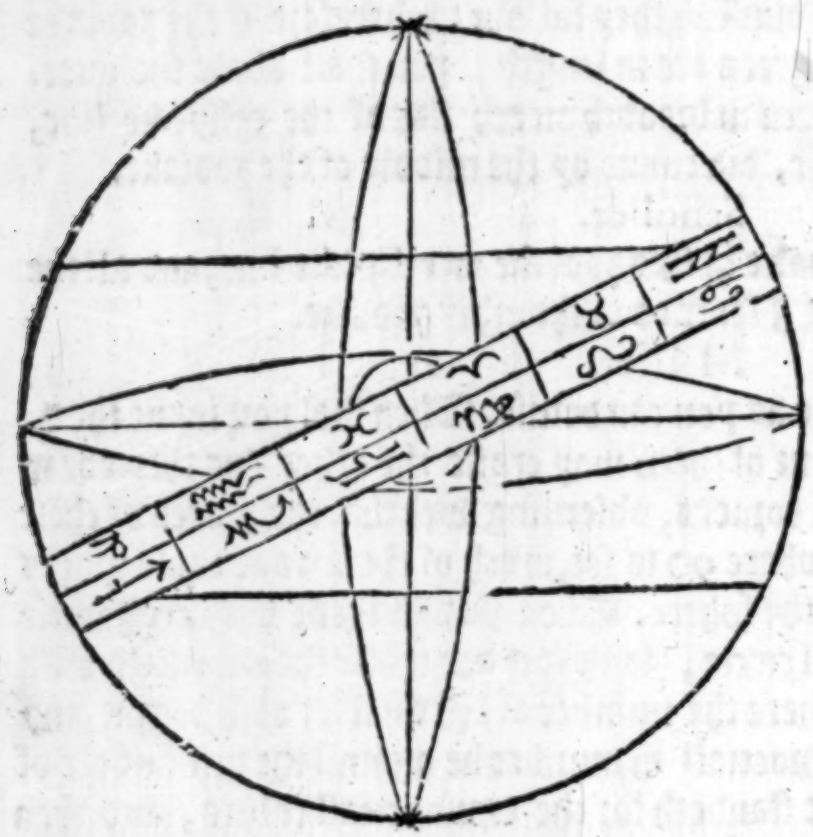
The poles. The 2 tropiks The Arctike and Antarcticke circles.

Now muſt you ſet the zodiake aſlopewiſe croſſe the equinoctiall, ſo that his middle line, named the Eclipticke line, may touch the middle of eache Tropike: and that may you try by the vtter edges of the breadth of the zodi-

The pole circles.

The zodiake. ake, for the one muſt touch the 29. degree and an halfe, and the other the 17. degree & an half from the equinoctial. And thus is this ſphere plainly made,

The Axe-tree, the Meridian and Horizont. whoſe picture I haue here ſet, as it will be drawne in a flat forme. Then if you make 2. ſmall holes through both the colures, in the places of their croſſing, where the poles of this ſphere are, and put a ſmall axe-tree through them, you may thereby ioyne this Sphere to his meridian firſt, and then place it in the Horizont, as you placed the globe: for thoſe two circles are like in both theſe ſpheres.



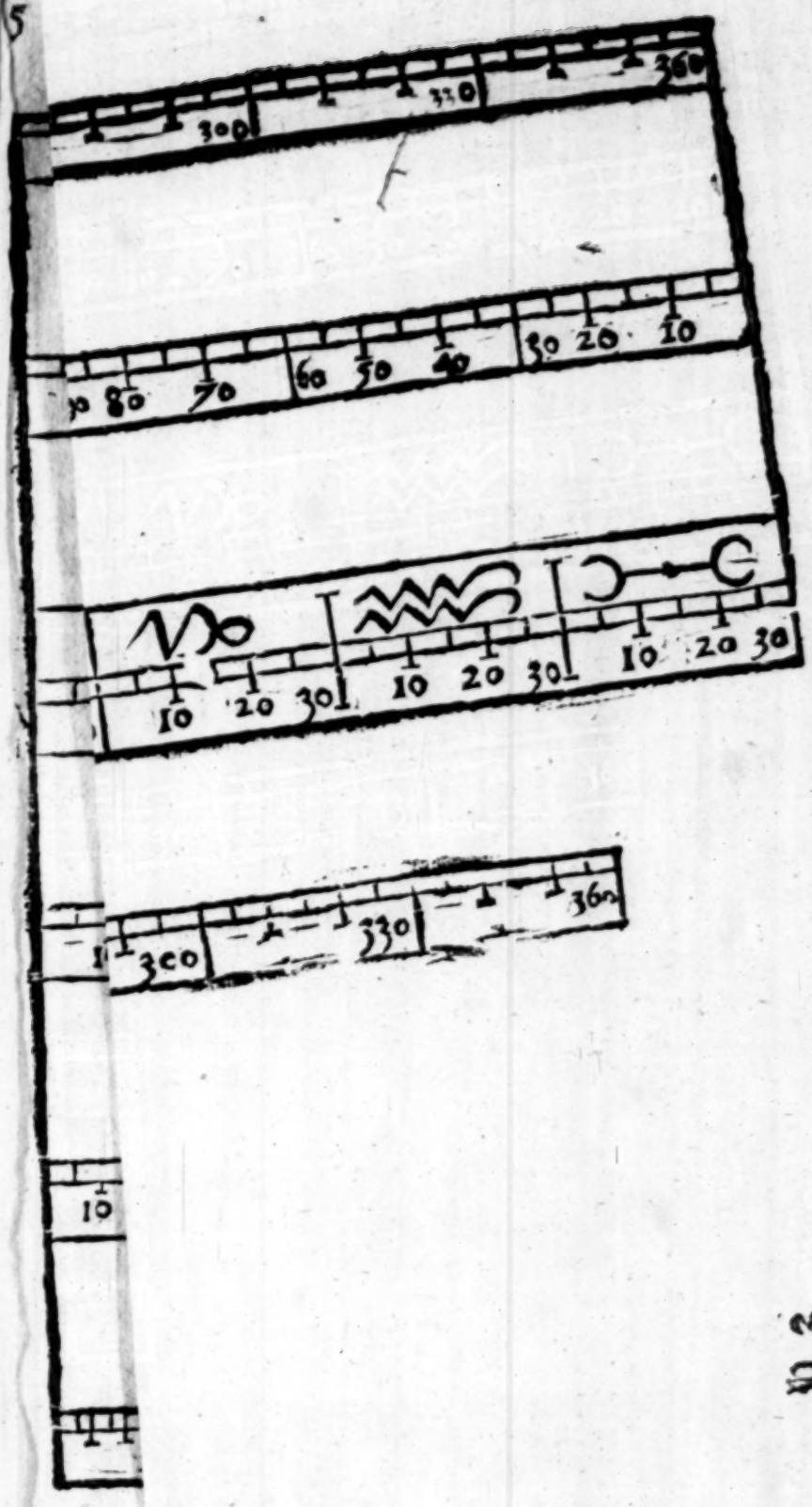
The proportion of the circles in a ſphere

Scholler.

I vnderſtand al things herein wel enough, as I thinke, ſaue that I doubt ſomewhat of the quantitie of the paralel circles: for although I know by triall I may at length make them meete, yet would I gladly know their meaſure before hand, if I might, for ſo ſhall I be ſure to worke moſt certainely.

Maiſter.

Your deſire is good, and albeit that the writers of the ſphere haue omitted it, as they haue done many things elſe, yet wil I giue you a rate of proportion drawen out of the tables of Cordes and Arkes, called commonly in Latin *Tabulæ Sinuum*. Firſt you vnderſtand, that the equinoctiall, the zodiake, and the 2. colures muſt be of one compaſſe, that is, of one bigneſſe, although not of one breadth, for the zodiake muſt be in breadth twelue degrees, and the other circles as ſmall as they may be and beare any ſtreſſe, for the ſmaller they be, the better they are, and moſt apt for the vſe of the ſphere. The other fiue paralels would be made as ſmall as they may beare conueniently, and in length they muſt haue 3. diuerſe rates, which I will here ſet forth, both in meaſure, and alſo in number, to the intent that you may alter the meaſure to what bigneſſe you liſt, by the help of the number. Lo here is their formes.



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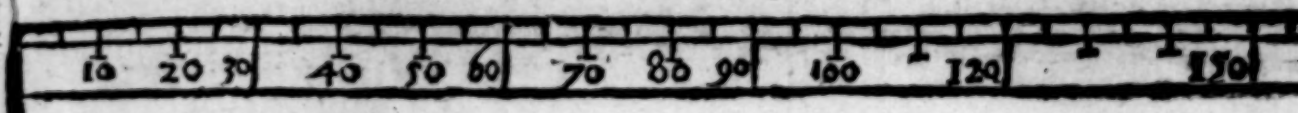
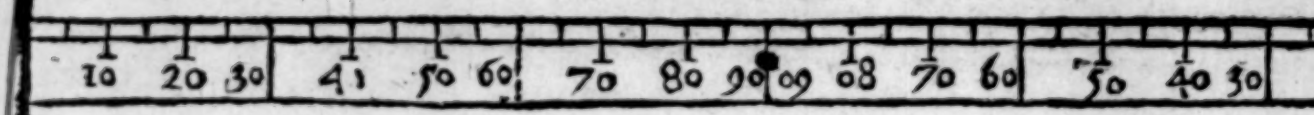
1 The Equinoctiall with his diuision.

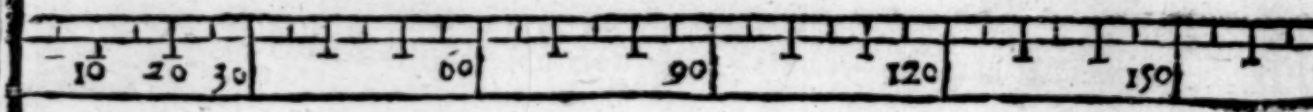


2 The Colures both of one forme.

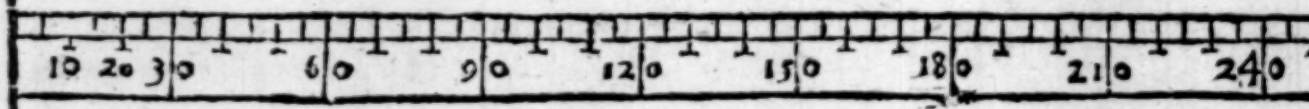


3 The zodiake with the twelue signes, and his

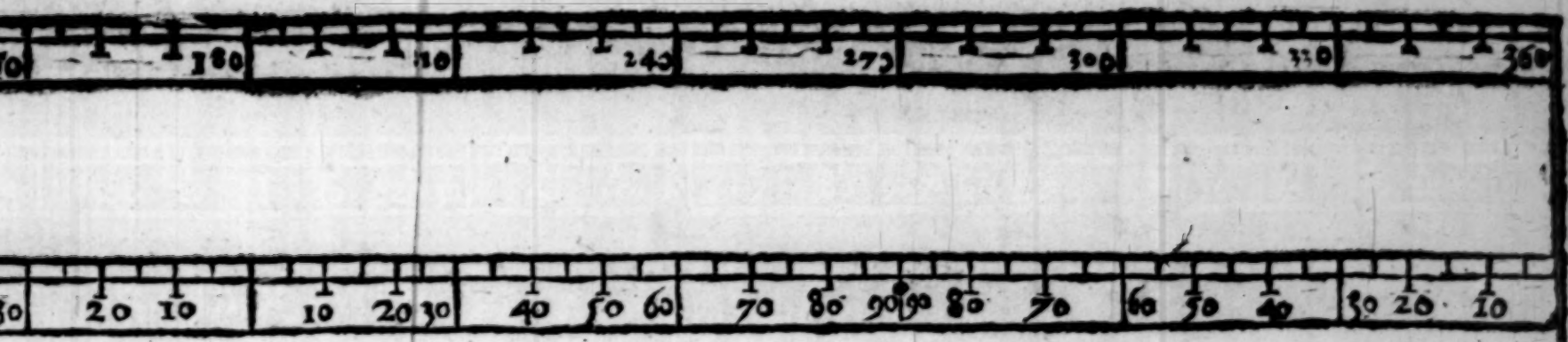
4 The length of the two Tropikes.



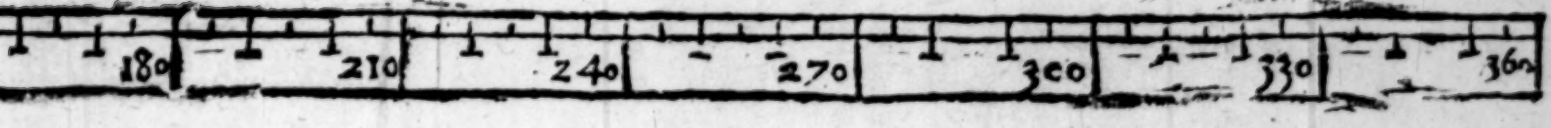
5 The proportion of the Arctike and Antarcti



6 The proportion in length of the two po



his breadth of twelue degrees.



arctike circles.

polare circles.

The zodiake.

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degree & an ha

The Axe-tree, the Meridian and Horizont.

whose picture

The proposition of the circles in a sphere

for although I
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to worke most

Your desire
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Here you see sixe seuerall formes.

The first representeth the iust length of that place or hoope, that shalbe the Equinoctial, and in it is the diuisions set forth as they ought to succeed in order, with their numbers agreeably.

The second is the forme, that serueth for the two Colures with their numbers and diuisions, as they should be set.

The third is the draught of the zodiak with his iust bredth of sixe degrees, and the 12. signes set forth with their degrees orderly. And these three circles be all of one length.

The fourth circle doth represent the due length of the two tropiks, which must be shorter then the equinoctial by 30. degrees, for it is equall to 330. partes of the same: so that the length of the tropike doth beare the same proportion to the equinoctial, as 11. doth to 12.

The fift place resembleth the measure of the circles Arctike and Antarctike, and is in length equall with 222. degrees of the equinoctial, which proportion is as 37. to 60.

The sixt plate setteth forth the iust measure of the two Pole circles, which is equall to 144. degrees of the equinoctial, and so it beareth to him the same proportion that 2. doth beare to 5. and eche of those circles Paralelles are diuided like vnto the equinoctial, into their 360. degrees.

Scholler.

This is so plainly set forth, and so certainly, that I see no doubtfulnesse now in the whole worke, for the making of it: for these places are so made, as if they were of metall, and should haue both the endes soudred togither. So that if anie man wil make them of wooden hoopes, he must allow so much more in the length of eche of them, as will suffise for to binde them fast in compassed forme. But these hoopes of this length will make but a very small sphere, yet by the same forme of the numbers, and their proportion, I may make a sphere of what bignesse that I will.

Maister.

So may you doe certainly: and if you will haue a sphere twise so much in compasse as these hoopes would make, or thrise or 4. times, and so forth, this measure also may serue you, taking for eche circle, so oftentimes the length of the like here in this pattern, as you wil haue your sphere greater then this in number of times.

Scholler.

And so I perceiue, if I would make another three times and an half so big as this, I ought to take the measure of eche circle three times and an halfe: and so for al other proportions.

Maister.

Trueth it is, saue that you must augment the bredth of the zodiake onely

in like number of times. But as for the other circles, they are broad enough if they be not too weak: for the ſmaller they be, the better is the Sphere, ſith their bredth doth ſerue onely for ſtrength, and for to receiue the diuiſions as here you ſee. And thus haue I deſcribed vnto you both ſorts of ſpheres, ỳ is, the Globe or maſſie Sphere, and the Perfect ſphere or Armille. One other forme of Sphere there is, which excelleth both theſe formes, and is wonderfull apt for the teaching and expreſſing of the Theorikes of Planets: therefore I will reſerue it to that place.

Heere needeth no repetition, becauſe all ſtandeth in working of the former leſſons before repeated, and therfore this ſecond treatiſe ſhal end heere.

The third Treatiſe, wherin is briefly taught *the vſe of the ſphere, for certain concluſions of dayly appearances, and other like matters.*

Maiſter.

The plages of the world.

Do you looke to heare ſomewhat of the vſe of the Sphere, as you ſhall doe anon: And for an induction therunto, you muſt diligently knowe the plages of the world, amongſt which there are foure principall, that is, the Eaſt, the Weſt, the North and the South: and betweene theſe are there other diuers, which are ſufficiently ſet forth in the Horizont of the Globe, as much as ſhall at this time be needfull.

The Paralelles in the earth

You muſt knowe alſo, that euerie one of the Paralelles in the heauen hath a like circle in the earth proportionably drawne, and anſwering to thoſe that are in heauen, in iuſt rate of diſtance. So is there

The earthly equinoctiall.

firſt an equinoctiall in the earth exactly drawn vnder that equinoctiall in heauen, and it diuideth the whole earth into two equall partes, betweene the

The middle of the earth.

South and the North, ſo that it pointeth preciſely the middle of the earth, in that reſpect: and all the partes of the earth from that earthly equinoctiall toward the North, is called the North part of the earth: and of the world likewiſe, al that is beyond that circle towards the South is called the South parts of the earth.

Scholler.

The north part of the earth. The South partes of the earth.

Yet we doe call that part only North, that is North from vs: and that we call South, that is South from vs.

Maiſt. You muſt conſider ỳ there is 2. formes of ſpeaking in ſuch talk, the

one

one vulgar, and commonly vſed, as wel of the vnlearned as of the learned, & that maketh not the comparison to the whole worlde, which fewe men doe knowe, but it regardeth principally their owne countrey, which they doe beſt know. The other talke is generall in forme of ſpeaking, becauſe it hath reſpect to the whole earth, and yet it is not generall in knowledge, for few men can aptly ſkill of it: ſo that both are true in their due vſe, but the one is leſſe knowne then the other.

Schol. So I perceiue then, ỹ although in cõmon talke we do call Spaine South, and likewiſe other countries, yet is not that true in comparison to the partes of the whole worlde, but in comparison to vs, for our commen talke hath chiefe relation in ſuch thinges to our owne countrey. But I pray you then, where is the middle of the earth, from which wee muſt make our accompt, and vnto which wee muſt haue regard in al ſuch general talke?

Maiſter.

That will I tell you anon, but firſt wee muſt end that matter wee began withall, touching the Paralelles on the earth, whereof I haue named yet only the Equinoctiall: but now muſt you imagine other two paralelles next vnto it, the one toward the South, and the other toward the North, which may anſwer to the two Tropikes. And for a generall knowledg firſt, vnderſtand this, that all nations ouer whoſe heads the ſun doth run directly, when he is in the higheſt point toward the north, that is in the beginning of Cancer, where hee deſcribeth the tropik of Cancer in the ſkie, all thoſe people I ſay dwel iuſt in the courſe of the like tropik in earth: And cõtrariwiſe, all thoſe people ouer whoſe heads ỹ ſun paſſeth

The Tropikes on the earth.

An example of the Paralelles in earth agreably to the Paralelles in the skie.

passeth directly, when he is in the Winter tropike, they dwell in the course of that South Tropike in earth, and haue the sunne right ouer their heades that day that he entereth into the first degree of Capricorne.

Scholler.

The other Paralelle.

By these examples I can imagine the South and North circles in the earth to be vnder the Antarctike and arctike circles in heauen, and so two Polare circles in earth vnder the two Pole circles in heauē. Then are there seuen Paralelles in earth, answering to seuen other in the skie.

Maister.

That is sufficient: howbeit for this time I will omit the circles arctike and antarctike, because in mine opinion, they make no Zone in earth, though all the Greekes in appearance doe say the contrary, but I will bring inuincible reason for my purpose, when wee come to the scanning of repugnant sentences, especially when I doe disagree with the Greekes, which are the fathers of wit: but in this point of the fiue Zones, I like much better our owne countrey man *Iohn de Sacro Bosco*, as I will now only affirme, and in the fourth treatise will proone it substantially. Therefore to continue our matter as wee began: there are made by these fiue paralelles, fiue large

Ioan. de Sacro Bosco Zonarum restaurator.

The fiue zones

roomes in the heauen, and other fiue in the earth, agreeable to them in heauen, which spaces are called Zones.

Scholler.

Example of Zones.

By your fauour, there are sixe Zones; if euery space betweene the Paralelles be accompted for one Zone, and that doth not onely the accompt of them

them by memorie declare vnto me, but alſo the ſight of them in this figure, which is commonly named the figure of zones.

Maiſter.

Neither doth the accompt deceiue you, neither yet the ſight of the figure, but want of knowledge of their naturall qualities, which therefore I will tel you by and by: though theſe paralelle circles doe ſufficiently diſtinct them, as their notable bounds, yet by their qualities be they diſtinct alſo. For as reaſon doth leade you, all the ſpace betweene the 2 Tropikes, muſt needs be eſteemed verie hote, becauſe the ſun runneth alwaies betweene them, ſo that in the middle betweene the two tropikes is the equinoctial line, from the which the Sunne is neuer fullie 24. degrees: ſo muſt it ſeeme to bee as hotte there in the middle of Winter, as it is in Spaine in the middle of Summer: and for this cauſe all the olde Coſmographers did thinke, that that countrey might not be inhabited for heate: and therefore called all that ſpace betweene the two tropikes, the burning zone, called in Latine *zona torrida*. And of eche ſide of it, they noted two zones, one vnder ech Pole, which they called the Froſen zones, (and are named in Latine, *Zonæ Frigidæ*) where for extreame cold, they thought that no man might dwell: and betweene thoſe Froſen zones, and the Burning zone, they appointed 2. temperat zones, (alled *zonæ temperatæ* of Latine men) which were partakers of the heate on the ſide, and of the colde on the other ſide: ſo that of both, there was made a temperat mixture. Now ſee you, that betweene the Equinoctial and the one Tropike, there is no other qualitie, then is betweene the ſame Equinoctiall and the other Tropike: wherefore all men (except onely Polybius) did accompt the ſpace betweene the Tropiks, but as one zone: ſo that the Equinoctial is the bound of no zone, but paſſeth by the middle of the burning zone.

The qualities of the fiue zones.

The burning zone.

The Froſen zones.

The temperat zones.

Scholler.

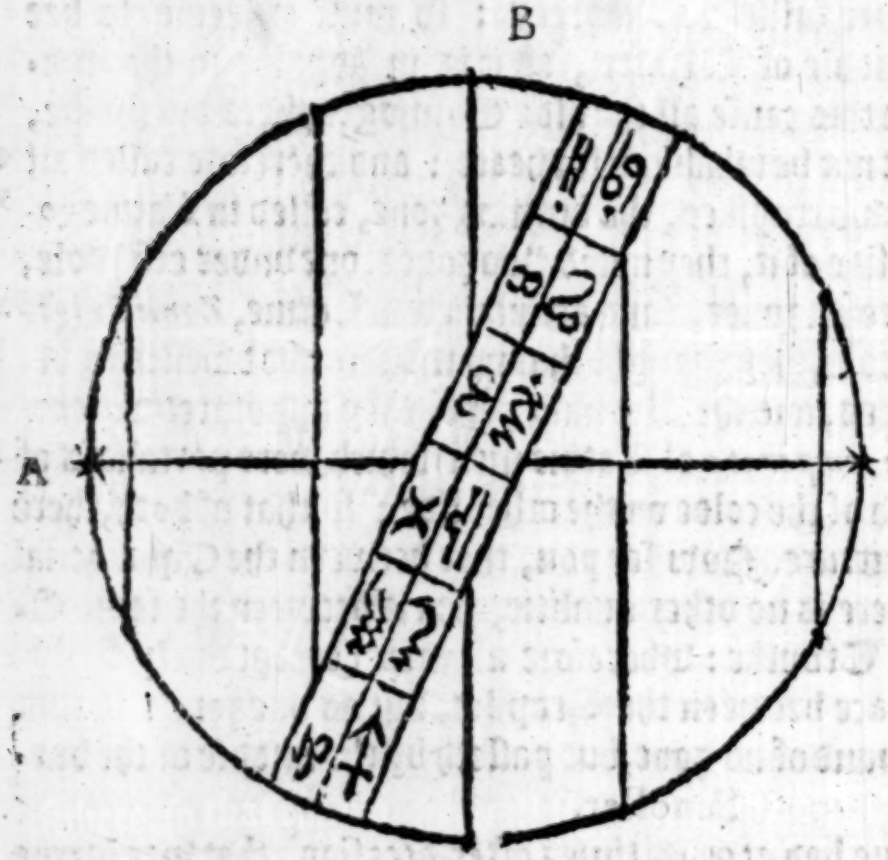
Now I ſee (as I haue had at other times often occaſion) that wee learne many thinges when we be children, which we vnderſtand not all when wee be men. for by this talke I remember, that both in Ouid and Virgil, I learned the diſtinction of thoſe 5. zones: but what was to be vnderſtood by them, I neuer knew till now. And now I ſee reaſon, that betweene the two Tropikes all may well bee accompted the Burning zone, where no man can dwell, as both my authors affirme.

Maiſter.

They had ſpoken more modeſtly, if they had ſaid, that there had bin painfull dwelling for heat: and likewiſe of the cold zones, that there is hard dwelling for cold: but of this wil I more exactly reaſon in another place, and for this time (as the trueth by experience is knowne) I ſuppoſe that all the fiue zones haue their inhabitantes, though not ſo plentifully as the two Temperate zones now haue, eſpecially this temperate zone that we dwel in. Who

is it that hath not heard of the Iſles of Molucca, and of Samatra, where the Portingales get the great plentie of rich drugs and fine ſpices? and al that haue been there, confeſſe that thoſe places are right vnder the Equinoctial line: and Calecut is but little from it, for it is more then 19. degrees beyond the tropike of Cancer toward the South, ſo that it is within fiue degrees of the verie Equinoctial line. Now therfore I think it moſt apt place for my purpoſe to beginne at theſe countries, ouer whoſe head the equinoctiall dothe rightly paſſe, ſo that they muſt needes ſee both the Poles in their Horizonte.

A C. The Horizonte.
B. The point ouer the head.
* The Poles of the world.
The Zodiak and the other circles doe appeare of themſelues.



Scholler.

That doth reaſonably followe, becauſe halfe the heauen iuſtly appeareth aboue the Horizont, & the other halfe is vnder the Horizont. And alſo I perceiue, that if I ſet the ſphere, ſo that the equinoctiall ſtand full vpright, then will both the Poles be in the very Horizont. As this poſition of the ſphere doth ſhew.

Maiſter.

A right ſphere. You conſider it right. And becauſe the Equinoctial doth croſſe the Horizont with right angles (for al 4. angles are equal) therefore is this placing of the ſphere called a right ſphere: ſo that al other nations, which haue the one pole aboue their horizont, muſt needes haue the other Pole vnder their horizont, and the equinoctial declineth from the point right ouer their heades, that way as the hidden pole is, whether it be toward the ſouth, or els toward the North.

Scholler.

The vſe of the materiall ſphere. Al this ſeemeth eaſie to me, as long as I behold this material ſphere: but when I doe not confer it with your words, then your ſayinges appeare the more doubtfull.

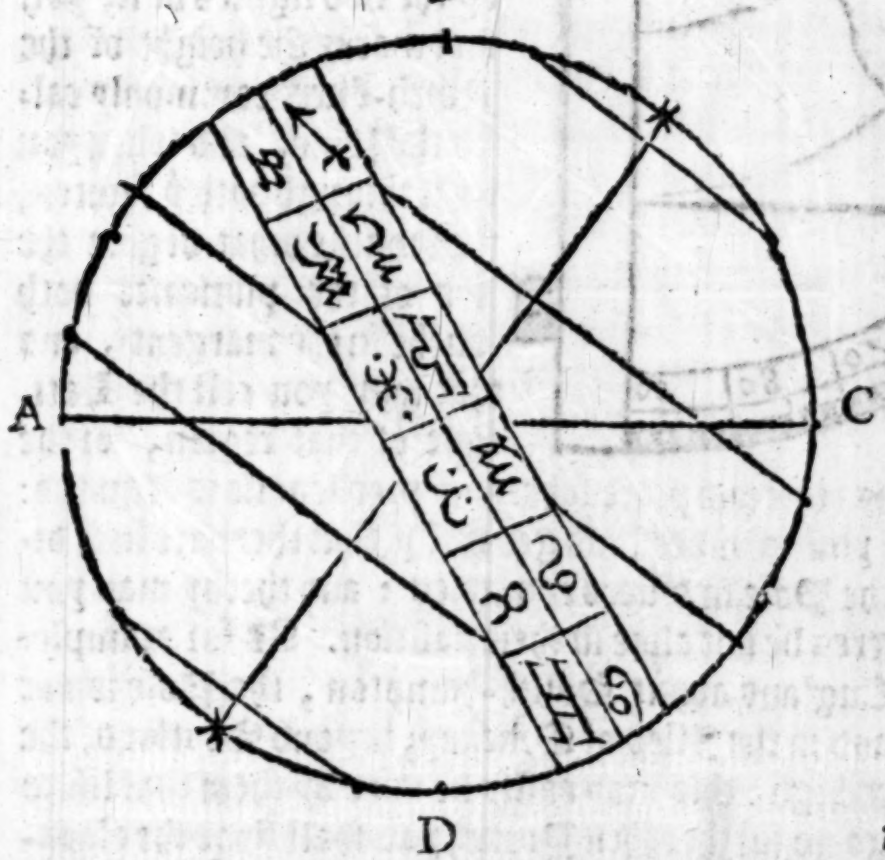
Maiſter.

Maiſter. For that cauſe did I teache you the making of it, before I inſtructed you in the vſe of it, knowing how great a helpe the ſight of the eye doth miniſter to the right and ſpeedie vnderſtanding of that which the eare doth heare. But againe to our matter: in al places where the equinoctiall doth decline from the point ouer the heads of any inhabitants (which point is commonly called the Zenith) there the equinoctiall maketh vnequal corners with the Horizont, and therefore is that called a Bowing ſphere, or a Leaning ſphere, becauſe the equinoctial boweth or leaneth towards one ſide of the Horizont, more then toward the other ſide. The Zenith. A bowing ſphere.

Scholler. I haue heard it called a Crooked ſphere alſo.

Maiſter. That name is vnapt for this art, for there can bee no crooked corner betweene the equinoctial and the Horizont, which might make that name meet for the matter: and (as I haue ſaide) the ſphere taketh thoſe ſeuerall names of his diuers poſition, and according to the corners that ỹ Equinoctiall doth make with the Horizont. And this may you conſider herein, ỹ there is no zone but one that can haue a right ſphere: and to ſpeak preciſely, but one tract in ỹ zone, which is the very middle of the Burning zone, right vnder the Equinoctial, wheras there be innumerable places ỹ haue leaning ſpheres, which you may call Oblique ſpheres or Declining ſpheres, if you delight more in Latine like names then Engliſh.

A. C. The Horizonte.
B. The Zenith.
*. The Poles.
The Zodiake, the equinoctial and the other circles doe appeare of themſelfe.



Schol. So I perceiue that both we and al other nations which dwel not right vnder ỹ equinoctial line, muſt be named to haue a Leaning ſphere. And this I conſider reaſonably, that in ſome countries the ſphere doth leane and bow more then it doth in other, which difference I would gladly vnderſtand.

Maister.

The diuersitie in leaning of any sphere, is agreeable to the elevation of the Pole in euery countrey, so that where the pole is highest aboue the Horizont, there the sphere leaneth most: and where the pole is lower and neerer to the ground, there the sphere leaneth lesser.

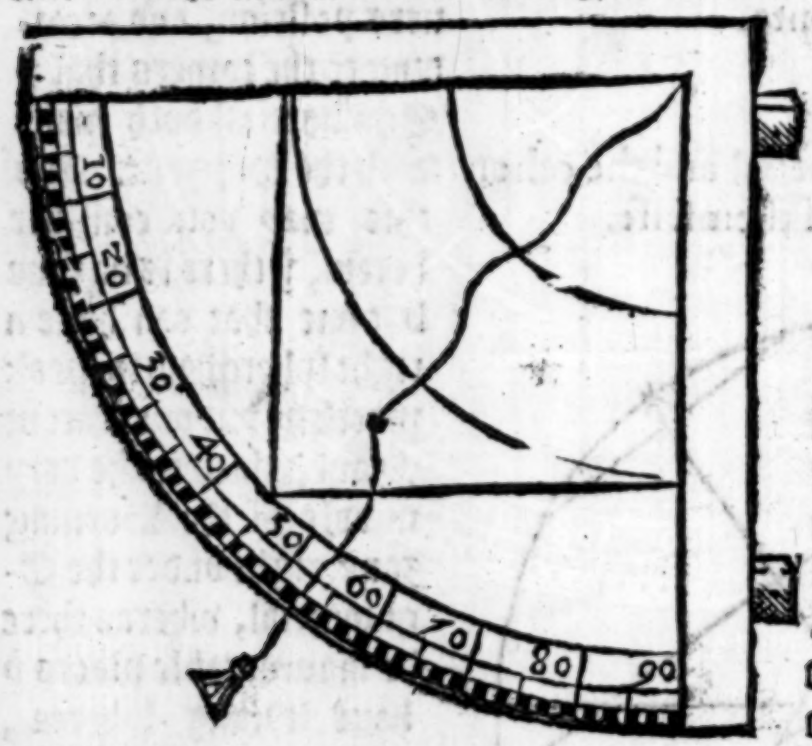
The height of the Pole.

Scholler.

How shal I iudge truely the height of the pole?

Maister.

That true and exact iudgement wil I not treate of as now, to auoid interruption in teaching: it shalbe sufficient for this place to shew you a plain and easie forme, with the vse of an instrument that may helpe you somewhat in marking the height of the sunne and moone and any other starres that you list. And the maner of it is thus. You shal take a quadrante (whose compositiō I haue taught amongst other Instrumentes in the Gate of knowledge but this which you see here, is ỹ form of the most plainest sort) and by the two sightes of it, you shal marke the height of the North-starre commonly called the Pole, and when you see it through both ỹ sightes, then marke what degree the line of the plummet doth touche in the margent, and that may you call the Latitude of that region, or the height of the Pole, for this time and place where no precisenesse is required: for now it is sufficient for you to vnderstand generally, that there are such diuersities of eleuation of the Pole in diuers countries: and therby may you vnderstand, that all Spheres be not alike in their position. As for example: In the South partes of England about South-hampton, the Pole is not fully 51. degrees high, and in the Iles of Orkenay, beyond Scotland, the Pole is aboue 62. degrees high: this may easily be tried by them that list to trauell, but if you list to go no further then Yorke, you shall finde the eleuation aboue 54. degrees, and so at Edinburgh shal you finde the eleuation about 57. degrees. And thus within your own countrey may you vnderstand a great diuersitie, whereby you may coniecture the diuersities that be in other partes of the world.



South-hampton.

Yorke.

Edinburgh.

Scholler.

Scholler.

This is ſo apparant to them that will trauell any thing for knowledges ſake, that they cannot pretend any ignorance, but wilful ignorance: but herein I finde one doubt, that maketh me to muſe, for in traueling thus from one place to another, whereby the pole is diuerſly changed in his eleuation, I can not thinke that the pole it ſelfe doth change his place, but that rather the horizont doth alter, from which we muſt take the meaſure of height of the pole. The alteration of the horizont

Maiſter.

You ſay wel, for indeede there is no ſuch motion in heauen that may make the pole ſo notably to change his place: but as we doe change our ſtanding, ſo doth there appeare a new horizont, which cauſeth the pole to ſeeme higher, if we go toward the north, for then we ſee more of the ſkie (that wayes) aboue our horizont, then we did ſee before: but if we go toward the ſouth, then wil the pole ſeeme lower and lower, ſtil as we go ſouthward: not becauſe the pole changeth, but our horizont changeth: for now we ſee more of the ſkie toward the ſouth, and leſſe toward the north: but yet generally as much as we leeſe in the one part, ſo much we winne in the other coaſt, ſo that euermore we may ſee halfe the ſkie.

Scholler.

Then this is my doubt, how I ſhal vnderſtand your former words: for I remember you ſaid, that the horizont was a circle immoueable, and did not turne as the circles in heauen do: and now you haue plainly declared that the horizont doth change, which cannot be without mouing of it. Whether the horizont doe moue or not.

Maiſter.

You haue anſwered your owne queſtion, if you marke it wel: for the horizont moueth not as the circles in heauen do moue, that is to ſay, it goeth not round about the earth by a daily courſe, but it ſtandeth ſteady while the heauen moueth, ſo that if you neuer change your place, your horizont wil neuer moue. And to ſpeake more exactly: the horizont moueth not, though you moue neuer ſo farre: but rather ſhould we ſay, that you are come into an other horizont, when you are come into another countrey.

Scholler.

It muſt needes appeare ſo, now that I doe conſider the matter more earneſtly: for when I am at London, I ſee the ſame horizont that al other men there do ſee: then if I go to Yorke, I ſee the horizont of Yorke, and not of London, ſo that the horizont of London remaineth as it was, and ſo doth the horizont of Yorke, whether I tarry or go. And thus I perceiue great alteration in the horizonts betweene ſouth and north, whereby the pole is diuerſly altered in height aboue the horizont. What if I goe eaſtward or weſtward, ſhal I not finde the like alteration?

Maiſter.

It must needs appeare yes: for the same reason that causeth you to change your horizont betweene south and north, the same will cause it to change betweene east and west. And for declaration thereof, answere me to this question: Do you suppose that there is any such country farre east from vs, as the Portingales report Calecut to be?

Example of Calecut.

Scholler.

It were as much folly to doubt of it, as it were to doubt of Babylon or Jerusalem.

Maister.

And suppose you, that the sunne doth rise to vs and to them at one time?

Scholler.

It cannot be: for this much I may gather by that I haue learned already, that the rising of the sunne, and of all other starres, is the appearing of them aboue the horizont: so that they rise to vs, when they beginne to appeare aboue our horizont: and they rise to them in Calecut, when they appeare aboue their horizont. And further I gather now by your briefe admonition of the change of the horizonts, that as betweene south and north in our owne country, we may perceiue notable diuersitie, so may wee consider the same much more in so great a distance as Calecut is noted to be from vs, which I heaue heard to be named aboue 15000. miles, and that is farre greater (yea 20. times) then al the length of England and Scotland together: wherfore I gather, that the diuersities of the horizonts must be twenty times so much as was betweene South-hampton and the north part of England.

Maister.

The distance is not so much, nor the difference so great, but by means that the Portingales do saile a maruellous compasse in going thither, they account the distance by that compassed course, which is farre from our talke now, for we must euer take right distance by a streight line, as often as wee doe speake of any such matter: howbeit, for examples sake, suppose it to bee 6000. miles east from vs, it seemeth to be more then a quarter of the whole compasse of all the earth, (as I wil proue in the next Treatise) therfore must the sunne at the least rise fiue houres to them sooner then it doth to vs: do you perceiue that?

The diuersities of the day in diuers regions.

Scholler.

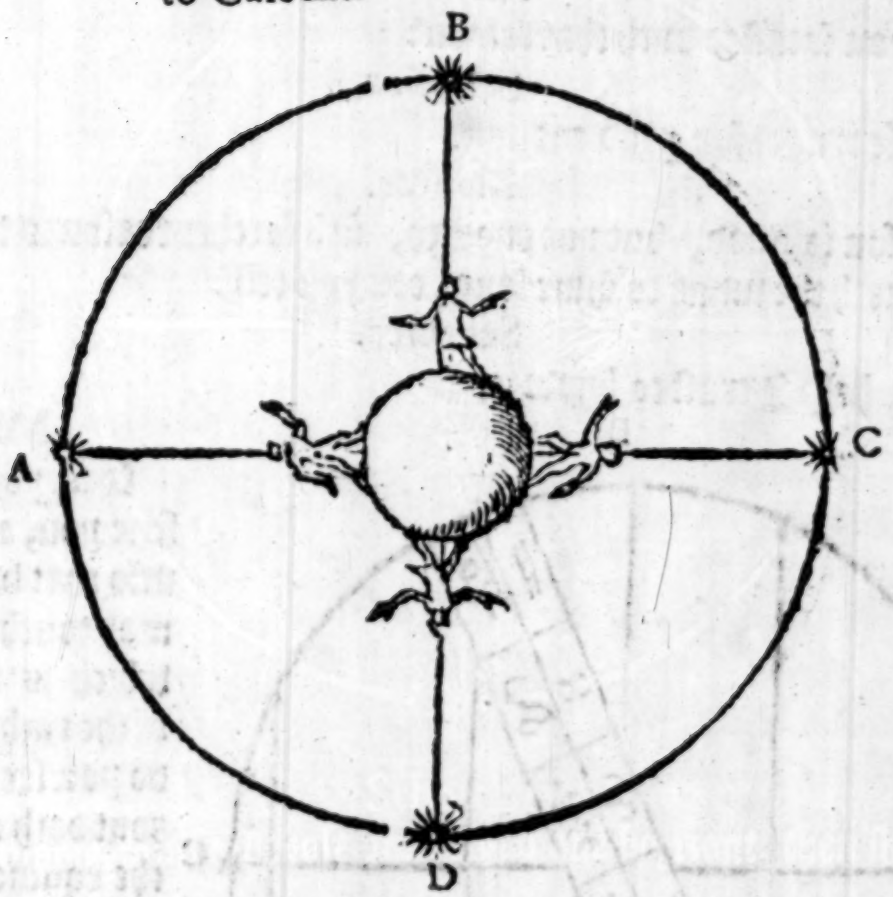
The sunne (as all men knowe) doeth compasse all the earth in foure and twenty houres, then must it compasse halfe the earth in twelue houres, and a quarter of the earth in fiue houres: this is as plaine as can be: and then it must needes follow, that if they be a quarter of the earth more towards the east then we, they must see the sunne fiue houres sooner then we.

Maister.

Euen so, they that dwell farther east than they, as the inhabitants of Moluca

lucca do, muſt needes ſee the ſunne before them: and thoſe that dwell more weſterly then they do, as at Jeruſalem, or at Conſtantinople, muſt haue the day ſpring later then they that be at Calecut. And thus you may conſider, that the horizonts do change as well betweene eaſt and weſt, as it doeth betweene ſouth and north: as this figure ſheweth for London and Calecut.

A C The horizont of London.
B The meridian of it.
A The eaſt to London, and the nooneſteede to Calecut.
D B The horizont to Calecut.
D The eaſt to Calecut, and the line of midnight to London.
C The weſt to London, and the line of midnight to Calecut.



Scholer.

That is plaine, for if all thoſe places had one horizont, then ſhould the ſun riſe to them all at once.

Maiſter.

And as their mornings do differ, ſo muſt their noonetide differ alſo.

Scholler. No man that hath reaſon can deny that.

Maiſter. Then muſt their meridian circles differ in like ſort, ſeeing they be the limites of the noonetide.

Scholler.

Scholler.

So I perceiue that betweene east and west the meridians doe change, as well as the horizons: and hereby I vnderstand, that when it is sunne rising at Calecut, it is not day with vs, by sixe houres: and when it is noone with them, it is six of the clocke in the morning with vs, and so of al other hourcs, which al appeareth by the former figure.

Maister.

The diuersities of dayes in one region.

This standeth for the declaration of diuersities of dayes in diuers regions: but yet you haue not heard what causeth the diuersities of days in one region.

Scholler.

Yes forsooth, I remember that you reproued me for saying that the long dayes caused the sunne to shine long: and you turned that sentence, affirming that the long shining of the sunne doth make the dayes long, and the short shining of the sunne doth make short dayes.

Maister.

And are you satisfied with that reason?

Scholler.

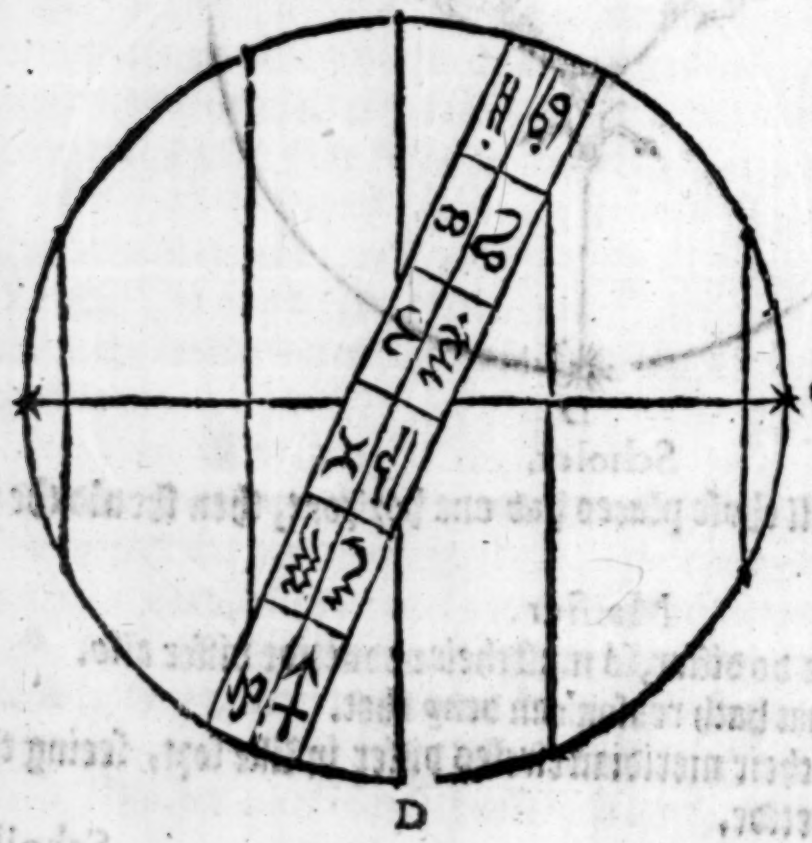
I suppose it a reason good enough.

Maister.

The reason is good, but not enough, sith further reason is to bee giuen. What maketh the sunne to shine long, can you tell?

Scholler.

By your help I trust to know it.



Maister.

Set your sphere before you, and first turne it so that both the poles may touch the horizont, which is the situation of the right sphere: then do you see that the horizont doth cut, not onelie the equinoctial circle in two equall halfes, but likewise it cutteth both the tropikes equally in to two euen partes, so that there is as much of eche of them aboue the ground, as there is beneath the horizont: and contra-

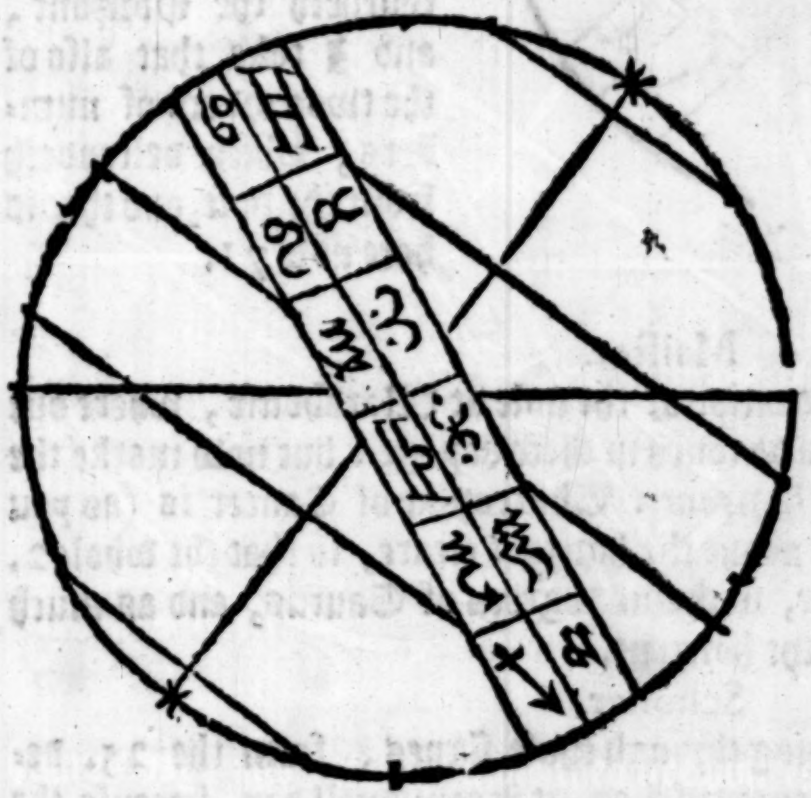
contrarie wayes. Wherefore it muſt needes appeare, that the ſunne when he runneth in any of thoſe three circles, is like time aboue the horizont, as he is vnder it: ſo muſt the dayes and the nights be equal, not only when the ſun is in the equinoctial circle, but alſo when he is in any of both the tropikes: but this equalitie of dayes and nights, when the ſunne is in any tropike, is priuately appropried to the right ſphere: for in al other varieties of howing ſpheres, then is the greateſt difference in all the yeare, betweene the day and the night, when the ſunne is in any of the tropikes: as for example: Set the ſphere to what eleuation you liſt, that is to ſay, Raiſe the pole as many degrees aboue the horizont as you will.

Scholler.

I haue ſet it now (as here you ſee) to the eleuation of 52. degrees, which you ſay is the eleuation at Cambridge.

Maiſter.

And now may you ſee that the equinoctial onely is equally diuided by the horizont, and that the two tropikes are very vnequally diuided, ſo that the tropike of Cancer hath almoſt three quarters aboue the horizont, and little more then a quarter vnder the horizont, where contrary wiſe the tropike of Capricorne, hath almoſt three quarters vnder the ground, and little more then one quarter aboue the horizont: whereof it muſt needes follow, that when the ſunne is in the ſummer tropike, he is almoſt three quarters of the Naturall day aboue ground, and little more then one quarter of the ſame day vnder ground.



Scholler.

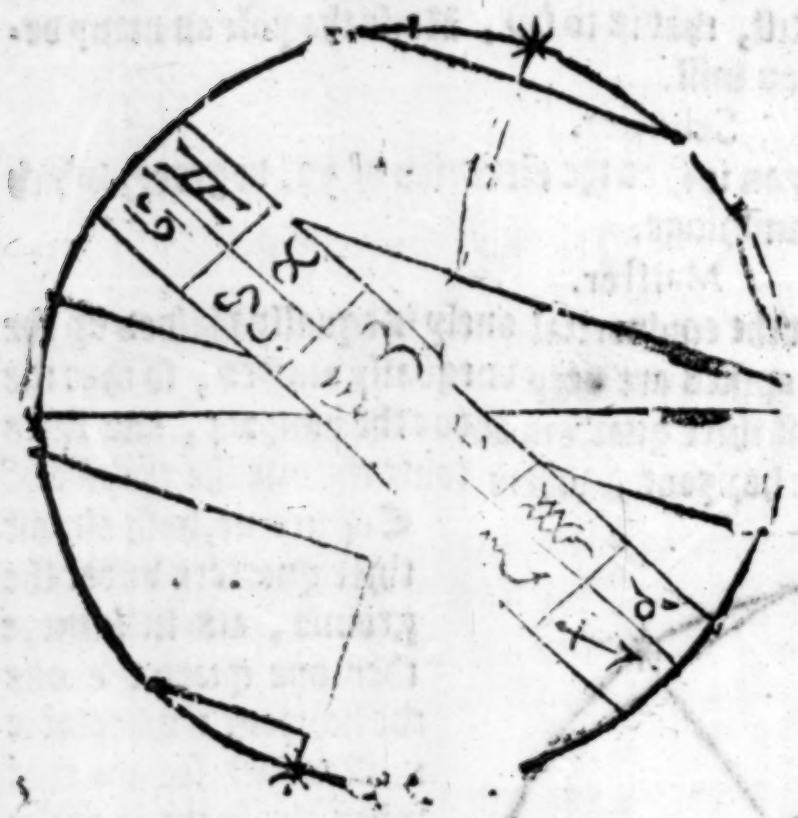
I knowe your minde very wel, and I do gather thereby, that when the day is at the longeſt, it is almoſt eightene houres day, and but little more then ſixe houres night. And contrariwiſe in the ſhorteſt of winter, the day is little more then ſixe houres long, and the night almoſt 18. houres. And farther, I heare you call the whole ſpace of 24. houres a naturall day: but I knowe not yet the reaſon of that name. 24 houres naturall day.

Maister.

An Artificiall day.

By addition of that name, the whole day of foure and twenty houres is distinct from the artificiall day, which is from sunne rising to sunne setting: and that artificiall day is most commonly vnderstoode, when men speake of the day: therefore for a difference it is good to vse such an addition. But nowe for the better practise, set your globe to some other eleuation.

Scholler.



I trow I haue set the pole high enough.

Maister.

Let it stand. What is the number of the eleuation?

Scholler.

I doe see betweene the pole and the horizont in the meridian diuers numbers, but I take that number onely, which toucheth the Horizont, and I take that also of the twoo orders of numbers, which descendeth from the pole, and that is here now 71.

Maister.

That is the latitude or eleuation of the pole at Wardhouse, where our new venturers into Moscouia do touch in their voyage: but now marke the varietie of the tropikes to the horizont: The tropike of Cancer is (as you see) more then foure degrees aboue the horizont cleare, so that the whole 2. signes of Gemini and Cancer, with fiue degrees of Taurus, and as much of Leo, doth neuer set vnder the horizont.

Scholler.

Then while the sunne is going through those signes, from the 25. degrees of Taurus, to the 6. degree of Leo, it is continuall day, because the Sunne doeth not sette vnder their horizont: but I pray you, how long time is that?

Maister.

The longest day at Wardhouse is 73. dayes.

It is from the seuenth day of Maie till the nineteenth day of July, so that it is continuall day with them by the space of threescore and thirteene of our dayes,

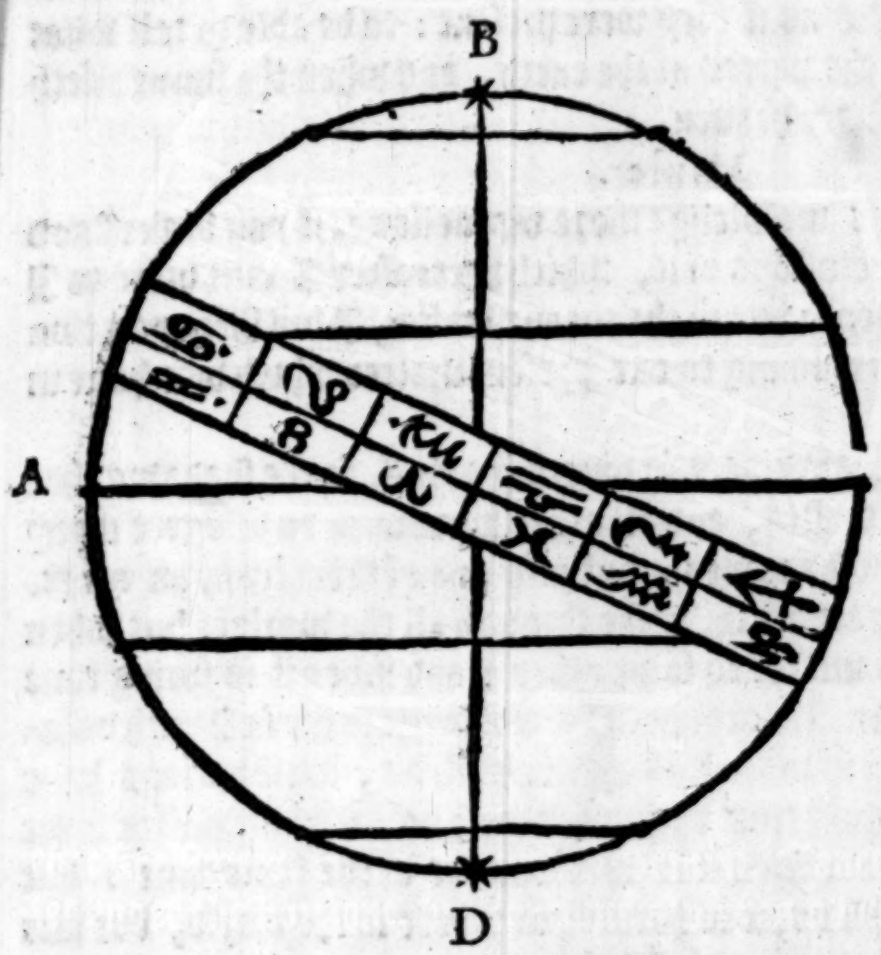
dayes, which is almoſt two moneths and an halfe.

Scholler.

This is maruellous ſtrange to me.

Maiſter.

Yet ſhall you heare more ſtrange matter then that: ſet your ſphere ſo, that the equinoctiall may be iuſtly in the horizont, and the north pole right vp in the place of the Zenith.



Scholler.

That haue I done, as here you may ſee.

Maiſter.

Now marke howe much of the zodiake doeth neuer goe vnder that horizont.

Scholler.

Howe ſhall I perceiue that?

Maiſter.

Turne the Sphere round, as it ſhoulde moue naturally on his owne poles, but ſtirre not the horizont.

Scholler.

Hereby I perceiue that ſixe ſignes, Aries, Taurus, Gemini, Cancer, Leo, Virgo, doe neuer ſet vnder the horizont, but continue alwayes aboue it.

Maiſter.

Then while the ſunne is in thoſe ſixe ſignes, hee can not be out of their ſight that dwell within that horizont.

Scholler.

It is trueth, if any body do dwell directly vnder the pole.

Maiſter.

It is not nowe my purpoſe to prooue what partes of the earth are inhabited (for that doth appertaine to Geographie) but to declare howe the Sunne doeth ſhewe in all partes of the worlde, as well on the ſea, as vpon land: and as well in wilderneſſe, as in populous countries. Whereby it

The length of the day vnder the poles of the worlde.

doth appeare ſufficiently, that vnder the poles of the worlde, it is halfe a yeere continuall day, and the other halfe yeare continuall night, becauſe ſo long againe the ſunne is not ſeene aboue that horizont.

Scholler.

This is as true as can be: the reaſon of it is ſo certaine and manifeſt, that I could not better vnderſtand the ſtate of that place, if I were there to ſee it, then I do by this beholding of the ſphere, and the motion of it. And this (as I take it) is a maruellous excellencie in knowledge, to be able ſo certainly to iudge of things abſent, as if they were preſent: to be able to tell what houre of the day it is in all the partes of the earth, and when the ſunne riſeth and ſetteth in all nations vnder heauen.

The excellency of knowledge.

Maiſter.

You would account this knowledge more maruellous, if you vnderſtood other more wonderfull concluſions in it, which hereafter I will utter as I ſhal haue occaſion conuenient: but in the meane ſeaſon, I wil ſhew you two or three concluſions, appertaining to our preſent matter which wee haue in hand.

As the houres of the day are diuers in diuers regions, ſo the ſhadows that the ſunne cauſeth in their dialles, and all other ſhadowes do diſagree many wayes, not onely from our ſhadowes, but alſo one of them from an other. Againe, the times of the yeare are not alike through all the worlde, but when it is ſummer to vs, it is winter to ſome other: and when it is ſpring time with vs, it is ſummer in an other country: and when it is harueſt with vs, other people haue ſummer: ſo when it is winter with vs, ſome nations haue ſummer: yea when the ſpring time beginneth with vs, it is harueſt in ſome countries, and in other countries it is midſummer at the ſame time: but when it is midſummer with vs, it is harueſt no where in the worlde, but mid winter it is then in two diuers parts of the world.

Scholler.

This talke is maruellous, and in mine opinion the greateſt maruell is, that you can vnderſtand the ſhadowes of their dialles or any other things in all parts of the worlde.

Maiſter.

Peraduenture it would ſeeme more maruellous if I ſhould ſay, that by the knowledge of the ſhadow of a ſtaffe, or any thing elſe that ſtandeth vpright (if I heare it truely reported) I wil tell you in what part of the world that ſhadow was marked. And thinke you this no maruell, to tarry within England, and yet to meaſure all the compaſſe of the earth, as certainely as any man can do it, by going round about the earth?

Scholler.

These thinges doe exceede credite, saue that other thinges, which before I iudged impossible, and now I know them certainly, doe perswade mee to thinke many thinges possible by learning, that seeme impossible to the ignorant, though their wits be neuer so good. I heare such men say sometimes, that learned men and farre trauellers may be permitted to talk at their pleasure, sith no man can controll them.

Maister.

By those wordes they signifie, that they doe not credite all that learned men doe write or say: wherefore I will constantly say to them, that if they would vouchsafe to imploy some time in learning, they should be easily perswaded, not only to beleeue such thinges as now they think impossible, but also to know them so certainly, as they know how many fingers they haue. But to perswade you in the meane season, I wil presently shew you some of these three conclusions before named, I meane for the general knowledge of the times of the yeare: for the declining of shadowes in diuers nations: and for the order to measure the whole earth, and yet go not out of England. Three conclusions.

Scholler.

If I may vnderstand but the generall forme of those three, I wil trust hereafter to attaine all the rest more certainly.

Maister.

I wil begin with the last, which seemeth most hardest, and I wil alledge nothing but that which you shal graunt vnto.

Scholler.

Then shal your proofe be as certaine as I can wish.

The declaration of the first conclusion for measuring the whole earth.

Maister.

Can you with a quadrant marke the eleuation of the Pole aboue the horizonte?

Scholler.

That is easie enough.

Maister.

Then marke it first at South-hampton, or in some other more Easterly place, on the South shore of England. After that go to Newcastle beyond Yorke, and there take the eleuation with your Quadrant againe, and marke it well, and the difference of those two eleuations shal you set in your tables, and by it you shall write the number of miles diligently and truely taken betweene those two places, where you tooke those two eleuations.

Scholler.

This can I doe with diligence, although it be as hard to marke the miles truely (the reportes of them being so diuers) as it is to worke truely with the Quadrante, but diligence wil auoid errour in them both.

Maister.

Then go forward to Edinburgh in Scotland, and marke the eleuation there: likewise go to the most northerly point of Catnesse, and take the eleuation there also, alwaies marking the difference of euery two places in miles of equall quantitie, and also the difference of the degrees of the pole in eche of those places from other, and set them in your tables in order the one by the other, as here for examples sake only, I haue set them.

The places	*The Eleuation of the Pole.*	*The difference in degrees.*	*The distance in myles.*
South-hampton.	51. 0.	0 0	000.
Newcastle.	55. 0.	4. 0.	240.
Edinburgh.	57. 0.	2. 0.	120.
Catnesse point.	62. 0.	5. 1.	300.
The summe of all.		11. 0.	660.

Here you see for South-hampton, where the first eleuation was taken, no myles set, because it is the beginning of your iourney, but the eleuation of of the Pole there is 51. degrees: then at Newcastle the height of the Pole is 55. degrees, and that is more then the other by foure degrees, so that 4. degrees must be set downe for their difference in degrees, and their distance in equal myles, is 240. Now to see how many myles doe answere to a degree, I doe diuide 240. by 4. and the quotient will be 60. Wherefore I say, that 60. miles in earth (by this triall) doth aunswere to one degree in heauen. Then at Edinburgh I finde the eleuation of the Pole to be 57. that is two degrees more then it was at Newcastle, and the distance between them in miles, is 120, which if I diuide by 2. the quotient will be 60. as it was before: so that one of these workes doth confirm the other, because they agree so iustly.

Scholler.

I vnderstand all this, as by declaring of the third worke it shal appeare to you. At Catnesse point, the pole is 62. degrees aboue the horizont, which maketh 5. degrees more then it was at Edinburgh, and the space betweene those two places is 300. miles: now if I diuide 300. by fiue, there will amount 60. which quotient doth agree with the other two before found: so it appeareth that in all England, 60. miles in earth answer to a degree of latitude in the skie.

Maister.

Proone you also the whole difference in degrees with the whole distance in myles.

Scholler.

Scholler.

The whole difference in degrees betweene South-hampton (where the Pole is 51. degrees high) and Catneſſe point, where the Latitude is 62.) doth amount vnto 11. degrees, and the diſtance in myles is 660: now diuiding 660. by 11, the quotient appeareth 60. agreeably as it was in all the other worꝛkes.

Maiſter.

What if you did go farther Noꝛth, 19. degrees moꝛe: I meane ſo farre Noꝛth that the pole were 81. degrees high aboue the hoꝛizont, howe many miles thinke you would that place be from South-hampton.

Scholler.

That can I quickly account by ẏ golden rule of pꝛopoꝛtion. The difference betweene thoſe two places in degrees is 30. Then ſeeing I found beſoꝛe, that 11. degrees gaue 660. myles, I ſet the numbers thus in their foꝛme of woꝛke, and then I multiply 660 by 30, whereof commeth 19800: which I muſt diuide by 11, and the quotient will be thus 1800.

660
30
19800

8
x 9800 (1800
xxx
x

11 Z 660.
30

Maiſter.

Thinke you this a true woꝛke?

Scholler.

This woꝛke is true and without any doubt, ſo that the meaſure of miles in England were true, which we take foꝛ our ground.

Maiſter.

And if that meaſure be not true, yet by that maner of woꝛking you may attaine to a very true rate of miles betweene South-hampton and Catneſſe.

Scholler.

That is no great matter, neither ſo hard to be done.

Maiſter.

And it is no greater matter, in both thoſe places to take the altitude of the Pole.

Scholler.

That is true alſo.

Maiſter.

So that if this rate be not true, there may be found a true rate by diligẽce.

Scholler.

Yea ſurely.

Maiſter.

And

And by that true rate you coulde finde howe many miles doth answere to 30 degrees in the skie.

Scholler.

Easily.

Maister.

Well then: Take this for a true rate, til you can finde an other more certaine. And now answere me: How many miles are in compasse round about the whole earth?

Scholler.

May that is impossible for mee to discusse yet, till I haue farther knowledge.

Maister.

See how easie a thing seemeth impossible to you. How many degrees are there in the compasse of the whole skie?

Scholler.

That can I certainly say to be 360: for as I learned before, a degree is no standing measure, but a rate of proportion, and doth betoken the 360. part of any circle.

Maister.

You say well. Nowe if the whole circumference of heauen be 360. degrees, I demaund of you, how manie miles doth answere to 360. degrees?

Scholler.

That may I doe as in the former worke, setting the numbers according to the rule of proportion. Then multiplying 1800, by 360, there riseth 648000, which I must diuide by 30, and so the quotiente will be 21600, whereby I know that 21600 myles, doth answere vnto 360. degrees in the skie. And so it should seeme that those are the iust number of miles about the earth.

The compasse of the whole earth.

1800
360
108000
54
648000

30 Z 1800
360

X
648000 (21600
333 0

Maister.

You need to make no doubt thereof, except you doubt whether there bee any part of the earth without the circuite of heauen: or els that you doubt, whether the earth be in the middle of the worlde.

Scholler.

The first doubt were too foolish, and for the second (albeit I doubt something of it) yet I assure my selfe by your promise, of the full proofe thereof in the next treatise.

Maister.

And other doubt there can be none, but this: Whether the earth and the ſkie bee both round. Which both I will ſo ſubſtantially proove vnto you, that no reaſonable man will doubt of it.

Scholler.

Then am I certified in the poſſibilitie of the moſt doubtful concluſion of the three, which you proponed: It may pleaſe you to proceede to the other two.

Maiſter.

You doe conſider that this concluſion being true, they that dwell 5400 miles from vs, doe dwell a quarter of the earth from vs. The declaration of the ſecond concluſion, for declining of ſhadowes.

Scholler.

That muſt needes be ſo: for foure times 5400. doth make the whole circuite of 21600. miles.

Maiſter.

And ſo they that dwell from vs any maner of way, 10800 miles, they dwell halfe the compaſſe of the whole earth from vs.

Scholler.

It followeth ſo by the former reaſon.

Maiſter.

It is wel knowne by the nauigations of the Portingals and Spaniards, that there is almoſt ſouth from vs, certaine places inhabited about 6300. miles, as namely at the ſtreight of Magellanus. Alſo at the great foreland of Affrike, commonly called the cape of Good hope, are there diuers regions repleniſhed with inhabitantes, and they be from vs Southward aboue 5200 miles: then northward we haue good knowledge of diuers countries beyond vs aboue 1200. miles, which both ioyned togither, doe make from the great foreland of Affrike aforeſaid in the ſouth, vnto Wardhouſe in the north part of Norway, about 6400. miles, which is more then a quarter of the compaſſe of the earth: but from Wardhouſe to Magellanus ſtreight, it is aboue 7500. miles: by which diſtance of miles, you may eaſily gather howe many degrees of the heauen eche of thoſe places is from vs, and from the equinoctiall. Magellanus ſtreight. The cape of Good hope.

Scholler.

Therein I pray you, that I may proove my new cunning. The cape of Good hope is from vs ſouthward 5200. miles, that is in the degrees of the ſkie 86 2/3, according to ỹ former rate of 60. miles to eche degree, from which number of 86 2/3. if I abate ſo many degrees as we bee North of the equinoctial, which are 52. degrees, then doth there reſt 34 2/3 degrees. So ỹ it appeareth hereby, that the ſaid foreland is 34 2/3 degrees South beyond the Equinoctiall.

60 Z 1
5200

44
5300 (86 2/3
660

Maister.

Now for Magellanus streight, proove the like worke.

Scholler.

It is 6300. miles Southward from vs: then by the rule of proportion, agreeably to the former rate, it must yeeld in degrees 105, out of which abating our distance north from the equinoctiall, (which is 52. degrees) and so remaineth 53. degrees. Thereby I vnderstand, that they are so far beyond the Equinoctial southward. Now will I proove for Wardhouse, how far it is North from the Equinoctiall. It is from vs toward the North 1200. miles, which must yeeld in degrees, after our former rate 20. from these 20. degrees I may not abate 52. degrees for our latitude, as I did before.

60 Z 1
6300
6300 (105
6 0

Maister.

It were against reason, seeing that the latitude, of Wardehouse is greater then our Latitude is, and lieth on the same coast of the Equinoctiall: for in the former examples the two places were on the contrarie coast of the Equinoctial from vs.

60 Z 1
1200
1200 (20.
6 0

Scholler.

I see it well nowe, so that by reason I must needes adde it to our elevation, and so there amounteth 72. degrees, which is one degree more then you did affirme it to haue in latitude, in your former declaration.

Maister.

The cause is this: that rate of 60. miles to ech degree doth serue in going precisely from South to North, but neither is Wardhouse iust North from vs, but somewhat toward the East, neither yet in the other two examples any of both places was directly South from vs: for the Forelonde of Affrik beareth toward the East, and ẏ Streight of Magellanus bendeth toward the West; yet for this time it may serue as well for our purpose, as if it were more precisely done.

An order in teaching.

Scholler.

Yet I thinke in teaching there shoulde bee vsed nothing but certaine trueth.

Maister.

Whatsoeuer is taught to be retained for a trueth, ought to be a very certaine trueth in deede: and they doe not well that in such maner do teach first vntruthes: but where induction is made by examples, it is oftentimes more, or at ẏ least no lesse expedient to vse examples not exactly true, then to take onely precise true examples: for therby it appeareth the mooke to be of greater

ter kynde, if it will proceede in an example which is not preciſely true. And in theſe examples we haue ſo large ſcope of triall, that wee neede not ſticke for two or three degrees: for I intend not to ſpeak particularly of any citie yᵗ is vnder one certain degree, but of whole prouinces, which occupieth diuers degrees in their Latitude: as you vnderſtand that the whole iſle of Britaine doth occupie from 51. degrees, vnto 62, which containeth 11. degrees. But now to come to our purpoſe: thus much you vnderſtand, that beyond the Equinoctial, yea and beyond the Tropike of Capricorne alſo, there bee inhabitantes.

Scholler.

Yea that there be, aboue 29. degrees by ſouth the Tropike of Capricorn: for that Tropike is but 23. degrees and a halfe beyond the equinoctiall: and there be inhabitants 53. degrees beyond the equinoctial, as before is ſhewed.

Maiſter.

Well, if there dwell men but 6. degrees by ſouth the tropike of Capricorne (for I ſaid before, I would not ſticke with you for a few degrees, ſith I woulde make my proofe the more forceable) then I demaund of you, which way doth the ſunne ſtand from them at noonetide?

Scholler.

It muſt needes be alwaies North from them at noone, as it is alwaies South from vs at noone, ſeeing they are beyond the South tropik, toward the South, as we are beyond the North Tropike toward the north.

Maiſter.

Then conſider two places that ſtand iuſt South and North (becauſe you like well a preciſeneſſe in examples) as Uenice that famous citie ſtandeth north almoſt from the cape of Good hope: Now conſider the matter thus: in theſe two places there is one common Meridian line, ſith they doe ſtand almoſt iuſt South and North the one from the other: and when the Sunne is in the Meridian line of Uenice, is hee not alſo in the Meridian line to them that dwell at the ſaid cape of Affrike?

Scholler.

Yes truely.

Maiſter.

Then thoſe two places haue their noone-tides at one houre.

Scholler.

So haue they.

Maiſter.

And at Uenice their ſhadow goeth alwaies at noone toward the North and neuer toward the South, becauſe it is far North from the northerly tropike, called the Tropike of Cancer, and ſo is the foreſaid cape of Affrike far ſouth, beyond the ſouth Tropike, which is the tropike of Capricorne: wherefore

(as you haue confeſſed) their ſhadow at noonetide, muſt needes go al times of the yeare toward the South.

Scholler.

So I ſee that thoſe two places haue a contrary propertie, touching their ſhadowes.

Maiſter.

That is parte of the thing that I did intend to ſhew vnto you: but yet they both doe agree in this point, that all times of the yeare their ſeuerall ſhadowes doe incline toward one coaſt.

Scholler.

That is true: for at Venice it goeth ſtill north, and at the cape of Good hope, it runneth alwaies ſouth.

Maiſter.

Single ſhadowed. Theſe ſort of people are named of the Greek Coſmographers *Heteroſcij* becauſe their ſhadowes goeth ſtill towards one coaſt.

Scholler.

As though there were other people, whoſe ſhadowes did ſometime go Southward, and other times northward: I meane their ſhadowes at noone; for els al nations haue in one day, at diuers houres, much diuerſitie in their ſhadowes.

Maiſter.

Ye vnderſtand the time wel: and you ſhall perceiue as wel, that there bee ſuch places, which change their ſhadowes. You confeſſe that men dwell beyond the Tropike of Capricorne Southward: and other you know do dwel beyond the tropike of Cancer northward: and thinke you it not agreeable to reaſon, that betweene theſe two peoples there doe dwell diuers nations in ſo great a plot of ground?

Scholler.

I thinke yes. And I heare ſay, by our owne countrey men, which trauel to Guinea, that they went beyond the ſunne, which alwaies I tooke to be a lie of libertie permitted to far trauellers, but now I perceiue it may be true in one ſence.

Maiſter.

There are two places of that name, and both are beyond the tropike of Cancer, toward the South, and the one of them is almoſt directly vnder the Equinoctial circle: and becauſe you haue named that countrey which our nation both well know, take it for your example. They of Guinea being nigh vnder the Equinoctial, haue the ſunne ſometimes north from them at noone, as when hee is in the Tropike of Cancer: and other times they haue the Sunne South from them, when he is in the Tropike of Capricorne: and muſt not their ſhadowes change in like ſort?

Scholler.

It

It cannot otherwiſe be. And ſo I ſee, that when it is midſummer with vs, then doth their ſhadowes goe ſouthward, to as many as dwell betweene both the tropikes: and in our mid wmter, their ſhadows go northward.

Maiſter.

Thoſe people are named of the Greekes *Amphiſcij*, becauſe the noone ſhadowes go both wayes, ſouth and north. Double ſhadowed.

Scholler.

And farther I gather, that there is no quarter in the horizont, but their ſhadow runneth that wayes ſome time in the yeere.

Maiſter.

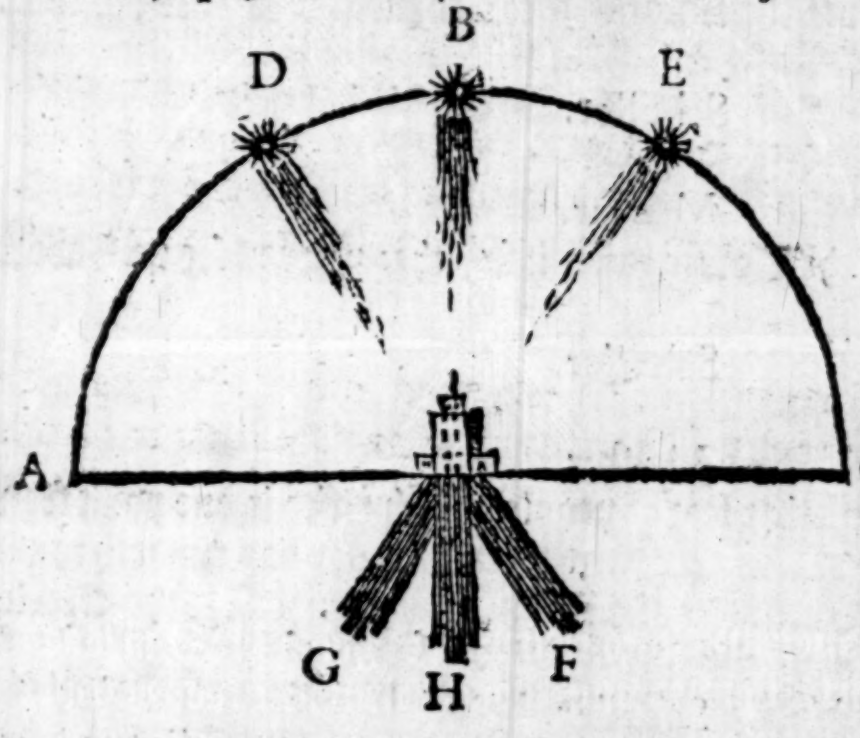
You ſay truely: but the chiefe regard is here giuen to the ſhadow at noontide, whereby you may conceiue, that ſometime they haue almoſt no ſhadow: for when the ſunne at noone is right ouer their heades, then their ſhadowe is right vnder their feete, and not on any ſide.

Scholler.

It muſt needs be ſo: for ſeeing the ſunne is ſometimes north of them, and ſometimes ſouth from them, he muſt needes twice in the yeere be right ouer their heads, once in going ſouthward, and againe comming northward.

Maiſter.

To helpe your memorie and coniecture, take this figure for a preſident and example, where I haue ſet the line A. C. for the horizont, & D B E. for diuers places of the ſunne at noone. Now if you do call A. the north point of the horizont, and C. the ſouth point, then when the ſunne is in D. toward the north from their heades, their ſhadow goeth to F. toward the ſouth. And when the ſunne is in E toward the ſouth, then is their ſhadow in G. heading toward the north: likewiſe the ſunne being right ouer their heads in B. their ſhadow muſt reſt in H. right vnder their feete: but I ſee by your countenance that your minde worketh in ſome ſtrange imagination: and I coniecture it to be, for that I haue drawen the ſhadowes beneath the horizont, as you take it.

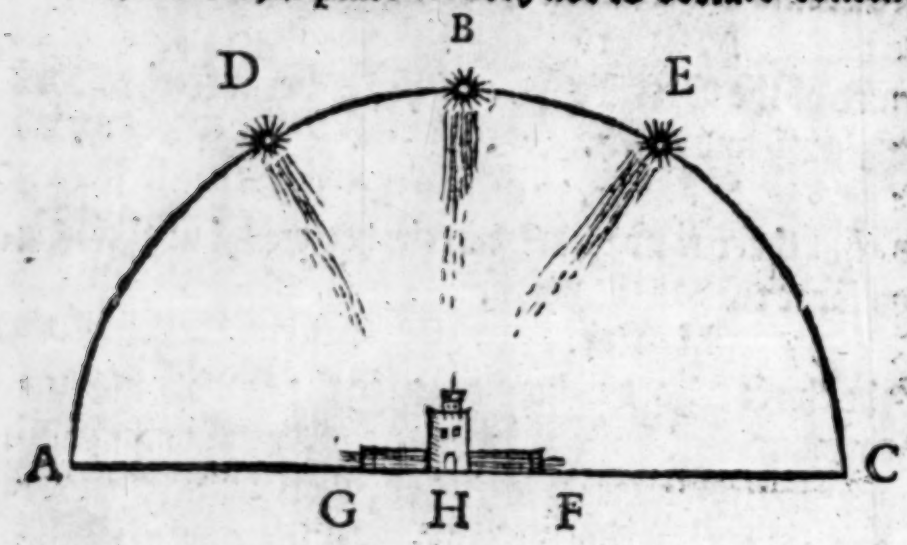


Scholler.

You haue truely coniectured my fantasie.

Maister.

Because this place serueth not to declare conclusions of by-matters, I will exhibite to you this other figure, where the shadowes doe runne on the horizont, agreeably to your fantasie, the letters of demonstration remaining as they were before, and both these tend to one end.



Scholler.

But here are but two shadowes.

Maister.

Where would you haue the third set?

Scholler.

Right vnder the tower that giueth the shadow.

Maister.

But it may not reach from the foote of the tower, neither toward one coast nor other.

Scholler.

No that it may not.

Maister.

Then doth the foote of the Tower couer it so, that you can see no shadow at all.

Scholler.

That is most certaine.

Maister.

Yet remaineth there an other sort of people, which differ in one point from these other two sorts, by reason that their shadow in one day runneth round about them, and goeth toward all coasts of the horizont, wherfore the Greeks call them *Periscij*.

Scholler.

Round shadowed. Is there no English nor Latine names for these sorts of properties?

Maister.

The Latine men borrowed of the Greekes, both their knowledge and also many names of Arte, because there is not the like grace of facilitie in composition, in the Latine tongue, as there is in the Greeke tongue, and therfore haue I giuen them no English names, because no one worde can aptly expresse

preſſe theſe properties, except I woulde triflingly make ſuch an imitation, to call them, One ſhadowes, Two ſhadowes, and Round ſhadows: or elſe, which is not much vnlike, ye may call them Single ſhadowed, Double ſhadowed, and Round ſhadowed.

Scholler.

That imitation ſeemeth ſtraunge, yet were it better to make new Engliſh names, then to lacke wordes: therefore I will not refuſe to vſe them, till I can learne more apt names: but I pray you, where do thoſe men dwel, that haue their ſhadowes running ſo about them?

Maiſter.

Within the polare circles: for all people whoſe zenith is within 23. degrees and a halfe of any of both the poles haue their ſhadows running round about them: but (as I ſhewed you before) the nearer they dwell vnder the pole, the longer is their day: and therefore the oftner doth their ſhadows run about them: for where the day is but 24 houres long, there the ſhadow runneth but once about: and where it is halfe a yere long, there it runneth about a hundred and three times: and in all other meane places accordingly.

Scholler.

This is manifeſt enough by your former declaration of the length of the dayes, and the courſe of the ſunne. And further I perceiue, that when they that be vnder the north pole haue their ſhadowes thus running about them, then they that dwell vnder the ſouth pole haue no ſhadowes at all, for it is continuall darkeneſſe with them.

Light and darkeneſſe vnder the poles.

Maiſter.

You ſay well, concerning the ſunne light, touching them that dwell directly vnder the poles, but yet they haue the light of the moone euery moneth more then 14. dayes together.

Scholler.

Then doe they not want light (though they lacke the ſunne) but only halfe a moneth together, when the moone is in that halfe of the zodiake, which is out of their horizont.

Maiſter.

That is wel conſidered of you. And yet euery month they lacke not light, though both the ſunne and the moone alſo be out of their ſight: for as you ſee with vs, that we haue light before the ſunne riſing, and after the ſunne ſetting, ſo haue they ſuch a light by the beames of the ſunne fiftie dayes continually after they haue loſt the ſight of the ſunne, and ſo haue they the like light fiftie dayes continuall, before the ſunne doth riſe to them.

Scholler.

Then they want not the ſunne light, but onely foureſcore and two dayes, although they ſee not the ſunne in halfe a yeere, and yet halfe that foureſcore

and

and two dayes they haue the moone in their sight, as I perceiue by your former lessons: for seeing she goeth about the zodiake euery moneth, shee must needes be halfe that time in that part of the zodiake which is alwayes aboue their horizont. This contemplation delighteth me much, to marke places absent, as if I were present, and to see their alterations by reason more certainely, then I can do by sense, if I were there presently.

Maister.

Yet will I withdrawe you from this matter, till another more conuenient place: and now will I proceede to the third conclusion mentioned before: that is the generall knowledge of the times of the yeare, in all parts of the world.

The third conclusion is declared.

When the sunne is at the highest with vs, it is at the lowest with diuers other nations, namely, to al them that dwel either vnder the equinoctiall circle directly, or south from it: and therefore all those nations haue midde winter, when we haue midde summer. But amongst them all, there is one region, which is as farre beyond the equinoctiall toward the south, as we are toward the north.

Scholler.

That region is about Magellanus streight, as I do gather by the second former conclusion.

Maister.

A climate.

Indeede the streight of Magellanus is in that region, for heere I meane by a Region that which the Greekes doe call a Climate, which is in forme like those zones, which I described before, saue that there are more such climates or regions, then there are zones: for the climates may well be accounted eight and fortie betweene the twoo polare circles, which containes but 3. of the zones: but of those climates I will say no more at this present, but that euery region where the longest day is halfe an houre longer or shorter then it is in any other region, must be accounted in a seuerall climate from it: so that vnder the equinoctiall the longest day is but twelue houres, and with vs in the middle of England, it is about eighteene houres: wherfore we must account that the middle of England is in the twelfth climate from the equinoctiall northward, and they that dwell 66. degrees and a halfe north, or south from the equinoctiall, because their longest day is of foure and twentie houres, that is twelue houres longer then it is in the middle of the world vnder the equinoctiall (from which all those accounts of climates doe beginne) they must be iudged in the 24. climate.

The number of climates.

Scholler.

Then are there foure and twentie climates on eche side of the equinoctiall, betweene it and the polare circles, yet I remember that the common authors make mention but only of seuen on either side, which maketh but foureteene in all.

Maister.

Maister.

That shall be answered anon, where I will set out the order and reason of the diuersitie of the climates: but for this time it shall suffice that you consider this, that all places within one climate, haue the times of the yeere alike exactly, and their daies still of like quantitie the one to the other, and they that dwell in the contrary climate, as many degrees on the other side of the equinoctial, they haue both the times of the yere contrary, and also the quantitie of the dayes disagreeable: for when it is summer in the one climate, it is winter in the other: and when the day in the one doth increase, the night in the other doth increase after the same quantitie iust.

The qualities of contrary climates.

Scholler.

Then for example: in the countrey about Magellanus streight, it is summer when we haue winter: and when our day is at the longest, then is their night at the longest.

Maister.

Trueth it is: and when we haue spring, then is their haruest: and so is it common to all them that dwell aboue the earth within those twoo climates, yet is there this difference, that in our climate and theirs also wee may imagine foure quarters equally distinct: the first quarter being that which wee dwell in, and in the contrary climate, our meridian circle limiteth the first quarter, and also the third quarter: so that in this first quarter in both climates, the times of the day and night are alike: for when it is noone to vs, it is noone to them: and when it is midnight to them, it is midnight also to vs

Euery climate hath foure quarters.

Scholler.

Then likewise when the sunne riseth to them, it riseth to vs, and so setteth at one time in both climates.

Maister.

We are farre deceiued, for then of necessitie must it followe, that their day and ours at one time should be of one quantitie, which is not true, as I saide before: but the reason of that shall be shewed anone: yet is it true, that their houres agree with our houres, if their meridian circle agree with ours. And the same meridian circle vnder ground doth limite in both these climates the third quarter also, where it is noone when wee in the first quarter haue midnight, and they haue midnight at our noone: nowe may you easily conceiue by your owne minde, the places of the other two quarters.

Scholler.

Order inforceth them, the one to be in our west, and the other to be in our east.

Maister.

That distinction is sufficient for you at this time, and it is precisely true, if you doe meane the east, where the sunne riseth at the beginning of the

spring time, or of the harueſt, wherefore for that time I will make mine example: when the sunne riseth to vs in the spring time, it is noone with them that dwell about Calecut, and when the sunne is in our meridian line, then doth he set to them: so that when the sunne doth set to vs, it is midnight to them about Calecut, and then is it noone to the famous country of Peru: Againe at that time the sunne riseth to them that be in the iſles of Molucca: whereby you may gather that Peru and Calecut be in two contrary coaſtes of the earth, and therefore seeme to goe with their feete the one against the other, and their heades the one fromward the other, which sort of people therefore are called of the Greekes and Latines also *Antipodes*, as you might say, Counterfooted, or Counterpaſers. Now to our purpose: al people that haue midnight when other haue noone, do differ insunder by halfe the compaſſe of the heauens one way: yet may they not be called *Antipodes*, except they differ in distance euery way a quarter of the skie, & muſt haue one meridian circle. So that our *Antipodes* muſt be vnder our meridian circle, and muſt be halfe the compaſſe of that circle from vs.

Calecut.

Peru.

Molucca.

Antipodes.

Scholler.

Then as we are 52. degrees north from the equinoctiall, so muſt they be 52. degrees south from the equinoctiall, in that parte of the meridian circle which is vnder our horizont, and then haue they midnight when wee haue noone: and hereby I perceiue that they haue midnight, when it is noone at Magellanus ſtreight.

Maiſter.

Indeede it is day then at Magellanus ſtreight, but not nigh noone, for Magellanus ſtreight is much too farre toward our weſt: but for examples sake that errour may be permitted, and especially, because there is no land, but sea, where you should meane that noone to be: so can you giue it no proper name: but retaining that name for example of the true place, you may consider three sorts of people, that is to say, our selues, and those that dwel by eaſt of Magellanus ſtreit, vnder our meridian circle, which haue noone when we haue noone, and the third sort which are vnder the same meridian, but haue midnight when we haue noone, and are as farre south from the equinoctiall, as we are north: whom I named our *Antipodes*, and so ought they to be called in respect to vs, and we are *Antipodes* to them also: But nowe comparing them with those other by eaſt Magellanus ſtreight, they are called each to other *Periœci*, as you may say, like dwellers, because they dwel vnder one meridian circle, and vnder one paralell also, and be like in distance from the equinoctiall circle.

Antipodes.

Scholler.

There are many places in euery such region or climate, but there are but two properly vnder one meridian, and the one of them hath midnight when the

other hath noone: ſo the times of the day doe differ with them, yet I perceiue that they haue the ſeaſons of the yeere agreeable, becauſe they dwel on one ſide of the equinoctiall. Then muſt it follow that thoſe which vnto vs be *Periœci*, are *Antipodes*, to them that dwell by Magellanus ſtreight vnder our meridian. Like dwellers.

Maiſter.

You ſay well, and we vnto them by eaſt Magellanus ſtreight, vnder our meridian, are called by the Greekes and Latins *Antichthones*, as you would ſay, Counter-dwellers, or Counter-climates. Counter-dwellers.

And thus haue you three ſortes of inhabitants by comparing the one with the other, whereof alwayes *Periœci* (that is Like-dwellers) haue like times of the yeare, but not of the day: *Antichthones* or Counter-dwellers, haue like times of the day, but not of the yeare. *Antipodes* or Counter-paſers, haue neither the partes of the yeare, neither of the day agreeable togither, but contrary in both: howbeit there is a further conſideration for exactneſſe of this knowledge, which I will hereafter declare to you in place more conuenient: but hereby may you gather the diuerſities of times of the yeare, and alſo of the dayes, according to the diuerſitie of the inhabitantes, comparing them all either to your owne country, or one of them to another, as occaſion ſhall ſerue, and opportunitie of matter. And thus will I end for this time, if I may perceiue by your repetition of this third Treatiſe, that you remember all things therein declared.

Scholler.

I were elſe too blame: but as I haue learned in it many ſeuerall things, ſo for the order of the Arte, theſe I note as chiefe matters: The repetition of the third Treatiſe.

1 Firſt, the diſtinction of the Plages of the world, accordingly as they be ſet forth in the horizont of the ſphere.

2 Then the paralels on earth agreeable to the paralels in the ſkie, of like names, and diſtance proportionable.

3 The diſtinction of the fiue zones, by their qualities and limites, and of their inhabitants.

4 The diuerſities of ſpheres according to their diuerſe inclinations, but two are the generall diſtinctions, that is, a Right ſphere, and a Bowing ſphere.

5 You gaue me a briefe order to take the height of the pole, or any other ſtarre or planet.

6 Then followed the diuers alterations of the horizont, as wel betweene eaſt and weſt, as betweene ſouth and north.

7 There was declared the cauſes of the diuerſities of the dayes, firſt in diuerſe regions, and then in one region.

8 The difference betweene a naturall day, and an artificiall day.

9 The quantitie of the longest day in certaine partes of the worlde, and namely vnder the poles of the world.

10 How by this excellent Art a man may measure all the compasse of the earth, and yet abide still in one countrey.

11 A distinction of sundry inhabitants, according to the diuersities of their shadowes, which are three principally.

12 Then lastly followed another distinction of inhabitants, according to the agreeablenesse and diuersities of times of the yeare, and the quarters of the day, and these you named by three seuerall names also, which are names of comparison, because they take not those names, but in comparison to other nations. This I remember to be the summe of this last Treatise.

Maister.

You remember it well, and vnderstand it also well, as appeareth by your repetition. Therefore now shall you depart for a time, and you shall reade ouer againe your authors of the sphere, which you did name before: and nowe marke whether you can vnderstand them, and at your returne, I wil instruct you more exactly in all the premisses, and diuers other conclusions, which now I haue omitted of purpose.

Scholler.

I am most earnestly bound vnto you for your great gentlenesse, which I pray God to requite, sith I cannot, and who will else, I know not.

Maister.

Farewell then, and remember your owne profite.

Scholler.

The Author of all profit continue and increase your profite, that you may haue quiet time to trauell for the profite of many.

The

The fourth Treatise of the Castle of Knowledge, *wherein are the proofes of all that is* taught before, and other diuers notable conclusions *annexed thereto: but nothing in a maner* without demonstration and good proofe.

Scholler.

IF the inexplicable benefite of knowledge did not enforce me to forget all bashfulnesse, I might think it too much shame, so often to trouble my Maister from his earnest studies, and to stay him from his profitable trauell with mine importune craving of knowledge, namely sith I cannot recompence anie part of his paines: yet his gentlenesse is such, that he seeketh more the profite of other, then his owne pleasure or peculiar commoditie: and therefore will I boldly enter his house. Are you at home sir?

Maister.

I am alwaies at home for my friendes, if I be not with them from home: yet sometimes I cannot be at home for my selfe.

Scholler.

The lesse for me and such as I am, that often trouble you more for our owne commoditie, then for your gaine.

Maister.

I seeke to gaine no more then competently may serue my necessarie vses, with conuenient regard to my charges: but if I offend any waies in coueting money, I assure you it is to beare the charges in setting forth such Monumentes of knowledge, as were maruellous profitable for all men, verie pleasant to many men, and yet esteemed only of wise men: But sith I can not doe the good that I would, and other want will which haue goodes in excesse, I must doe as manie others doe, wishe good to all men, and help them as I can. And for your part I look for none other recompense but this, that you alwaies be thankefull to your Maister: And as hee helpeth you freely, so doe you helpe other againe, and hide not the knowledge priuately, which may profite manie publickly. But now to your matter; haue you perused

ruled the authors of the Sphere which are commonly read?

Scholler.

To reade them all, it were too much for my life time, and the profite nor so great, as I heare manie men say: for as the number are infinite, so the later writers doe most commonly but repeate that that two or three of the auncientes haue written before. Wherefore, as I learned that the best writers of them for my studie, were *Proclus*, *Ioannes de Sacro Bosco*, and *Orontius* the French man, so haue I read them, and out of them haue I collected a table of their most notable matters, which as yet I vnderstand not, or els do desire to heare the demonstrations for their proofe.

Maister.

You haue done well in both pointes: for as the number of writers are infinite, so haue I found great tedious paine in reading a great multitude of thē. Notwithstanding as you shal hereafter seek further knowledge, so must you reade more writers in that matter: wherefore amongst a great number worthy the reading, I wil name a few vnto you, which I wish you to studie: and the residue I leaue to your owne discretion. Cleomedes the Greeke author, is verie worthy to be often read: but best in his owne tongue, for the Latine booke is much corrupted. Also Euclide his booke entituled *Phænomena*, and Stoffler his Commentaries vpon Proclus Sphere: which booke I wish were well recognised (as it hath great neede) then might it serue in stead of a great number of other bookes. Diuers English men haue written right wel in that argument: as Grosthead, Michell Scotte, Batecombe, Baconthorpe, and diuers other, but few of their bookes are printed as yet: therfore I wil stay at those three for this time. As for Plinie, Hyginius, Aratus, and a great manie other, are to be read only of maisters in such arte, that can iudge the chaffe from the corne. And Ptolomie that worthy writer and myracle in nature, is too hard for young Schollers, except they be first instructed not only in the principles of the Sphere, but also well traded in Euclides his Geometrie, and also well exercised in the Theorikes of the Planets. But nowe let me see the table that you haue collected.

1 The order and moouings of the nine Spheres.
2 The spaces of their reuolutions by their proper motions.
3 The forme of heauen is round, and his moouinges circulare.
4 The earth is round in forme, and the water also.
5 The earth is in the middle & centre of the world, and is but as a point in comparison to the firmament, and doth not mooue any waies.
6 The compasse of the earth, and the diameter of it, what they make in common myles.
7 Of the circles in heauen what is their iust quantities, their number, their

their order, their diſtaunce, and their Offices.

8 Why the Zodiake hath that name, and whether anie ſuch formes be in the ſkie.

9 The diuers ſignifications of a figure, and the declining of them. There are two Horizontes, one ſenſible, and the other only iudged by reaſon, and what the quantities of them both are.

10 The Greekes and the Latines doe not agree in the deſcription of the circles Arctike and Antarctike, and what are their reaſons.

11 Whether there be anie dwellers in the Untemperate Zones.

12 What be the circles Uerticall and circles of Height, the circles of houres, and of the twelue houſes.

13 Of the riſing and ſetting of the ſignes and other ſtarres, both in the right ſphere, and alſo in the bowing Sphere, after the Aſtronomers.

14 Of the Latitude of the ſunne and the twelue ſignes from the Eaſt and Weſt.

15 Of the riſing and ſetting of the Starres, after the mindes of the Poetes.

16 Of the diuerſitie of Natural daies, as well as of Artificiall daies in diuers partes of the earth.

17 The diuerſities of houres, whereof ſome are equall, and other vnequall according to the courſe of the ſunne.

18 The height of the Sunne aboue the Horizont at all houres, and in al Regions.

19 The diuerſities of ſhadowes, whereof ſome be called right ſhadows, and other be called Turned ſhadowes.

20 The diſtinction of the circles Paralelles neceſſarie in Coſmographie, with the proportion of their degrees, to the degrees of the Equinoctial.

21 The diſtinction of Climates and the number of them, and how large in bredth eche of them is.

22 Of the Longitude and Latitude of Regions and other places, and how both theſe ought to be taken.

23 The deſcription of the Milke way in the ſkie, which is commonly called Watling ſtreet, and what is the cauſe of that colour in it.

24 The number and names of the chiefe ſignes and figures that be in the ſkie, and why they be ſo called.

25 Of the circles and moouinges of the Planets, and namely of the Eclipſes of the Sunne and the Moone.

Theſe be the titles of ſuch matters as I haue noted in them moſt meete for this time; ſith manie other thinges are ſufficiently taught in the former treatiſes, and ſome other thinges, namely in Orontius booke, appertaine to

Coſmo-

graphie, which I perceiued by your sayinges, you minde to reserue for a peculiar treatise of that matter, and therefore I haue omitted them here.

Maister.

So might you haue done some other things also, which you haue noted here: howbeit I will vse my libertie therein, to expresse in conuenient largenesse those thinges, that be meete for this place, and the rest will I touche with as conuenient briefenesse, referring the other to their more conuenient places.

Scholler.

Sir I know right well, that your iudgement is as well to bee followed in the order of teaching, and choise of matter, as it is to be esteemed in the teaching and explication of all doubtfull cases.

Maister.

In order of teaching is more credite to be giuen to a maister, then in affirming of any doctrine: for the order is by long experience best knowne of such men: but for affirming of anie doubtful doctrine, no man ought to say anie more then he can shew good reason, for the approouing of the same. And now to your matter. Although you follow the order of *Ioannes de Sacro bosco* in manie of your propositions, yet wil I begin with your third proposition, and referre the two first to a more meete place, sith the proofe of them cannot wel be vnderstood, without a great number of other conclusions, which must first be proued. And for to begin with the declaration of the roundnesse of the skie, and his circulare motion, I thinke it good to follow that order which mooued men first to obserue this kinde of arte.

The first occasion to thinke the world to be round.

At the first beginning of the world, when this arte was vnknowne, men marked the rising of the sun and the moone, and other notable starres, as the Brood-henne, which is called of many men the Seuen starres, and other like: and perceiuing them to rise alwaies about the East, and so to ascend by little and little to the South, from whence they did descend againe softly to the West, where they did continually set: and the next day again they perceiued them to begin their accustomed course, and so continued like as before: wherein although they sawe some diuersitie, yet they perceiued that diuersitie to be vniforme, and after a yeare to returne to the old state again. By this occasion they beganne to imagine that this maner of mooving could not bee but in a round and circular forme, and also in a round and circulare bodie.

The second occasion.

Then to vnderstand this matter the more exactly, they obserued the mooinges of such starres as neuer go vnder ground, which be about the North pole: and there they perceiued by diligent marking of them, especially in the long winter nightes, and that at sundrie times, that they turned round about one point in the skie: and those starres that were nigh to that point did make but a little compasse in their mooving, and the farther that anie starres were from

from that point, the greater was the circle of their reuolution. Then thirdly they marked certaine notable ſtarres, which did riſe and ſet; but yet were not farre from thoſe other ſtarres which doe neuer riſe nor ſet, and they might wel perceiue that they did continue but a little while vnder the Horizont out of ſight, whereas contrariwiſe, thoſe ſtars that were farther from that point or pole, did remaine longer time vnder the Horizont, out of their ſight, wherby they were enforced to thinke, that theſe varieties and formes of mooving could be in none other maner of body then in a round forme, and that the ſame mooving was circulare and round, as it did manifeſtly appeare in the north part of the ſkie, where the ſtarres continually mooue round about one point, and do neuer ſet vnder the Horizont. And that point about which they noted this motion to be, they called (as reaſon inforced them) the Pole of the world. The third occaſion.

Scholler.

What doth that word ſignifie?

Maiſter.

It hath his name of turning: as you would ſay, a Turne point. And it doth betoken the end and extreme point of anie Axetree, howbeit by ſpeciall prerogatiue the name is appropried to the endes of the Axetree of the world.

Scholler.

This picture doth ſomewhat repreſent the motion of the ſtarres about the North Pole.

Maiſter.

You ſay trueth. Howbeit aptly it cannot be perceiued in flat forme, but in a round body, as a Globe is: but in that point (mee thinketh) there is no better inſtrument then the ſkie it ſelfe, where euery man may learne that liſteth to marke, and there be certaine notable ſtarres in that place: and namely Charles wayne, which is called alſo the great Beare, whoſe motion is ſo euident, that euery childe may marke it; And twiſe in the yeare, that is in ỹ middle A pole.

middle of Februarie and in the midst of August, they serue for a iust horologe: so that the finger in a clocke doth not more aptly point the houres, then doth that figure of Charles Waine.

Charles Waine.

Scholler.

There can be no more apt declaration of the roundnesse of the heauen, and of his circulare motion, then the sight of those starres which moue so roundly, and keepe their quarters in heauen so precisely. And yet I haue heard of certaine great clerkes, that in no case thought it reasonable to affirme such a forme of roundnesse, or such a round motion in heauen: but most of all I maruell of that famous man Lactantius Firmianus, which doth affirme (as I haue heard) that the heauen is not round, but flat and plaine.

Lactantius Firmianus his error.

Maister.

Manie scrupulous diuines by misse-vnderstanding of Scripture, haue abhorred the studie of Astronomie, and also of Philosophie: and oftentimes doe more sharply then discreetly raile at these both, & yet vnderstand they not any thing in either of thē both. Such men are too hastie to be good iudges, that will so quickly pronounce sentence, before they haue any good euidence, and wil determine the case, before they vnderstand the matter, for howe can anie man vnderstand wel or iudge rightly that thing that he knoweth not: yet such drowsie dreamers haue oftentimes deceiued many wise men, with their appearant reasons, but yet none but such as either were giuen to hate the name of philosophy, or els at least had no time, or none abilitie to get vnderstanding in it. By some such men I may think that Lactantius was seduced: and the more easily, for that he had conceiued a deadly hatred against al philosophers and against philosophie it selfe: but I will let him and his followers passe, and returne to the matter.

Lactantius opinion of the forme of heauen, Lib. 3. c. 24.

Scholler.

Yet if it please you, I would gladly heare his reasons, that hee maketh for approouing his opinion, seeing he is named so great an orator, and so famous in learning, that many men will beleeue him without any reason.

Maister.

Whosoeuer wil beleeue him in this point, must doe it without reason: for he alleageth no reason for his purpose, but taketh it as a certaine trueth, thereby to improoue the opinion of the Antipodes, as I will more largely declare anon in prooving the roundnesse of the earth. But seeing he coulde bring no reason for his opinion, you shal heare some reason against his phantasie, and then iudge as you can.

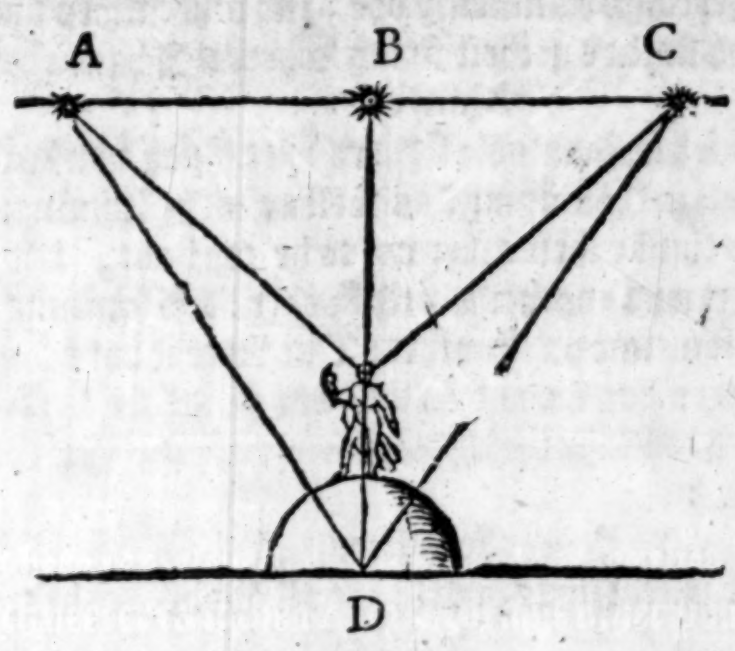
First I reason thus: If the heauen be flat and plaine as a bord, then howsoeuer it stand, one part of it must needes be neerer to the earth then anie other part of it. And that part by all likelihood must be right ouer our heades, is not that so?

That the skie is not flat.

Scholler.

Scholler.

I cannot imagine els any forme of ſituation: and that doth appeare partly in this figure, where A.B.C. ſtandeth for the ſkie: and lieth flat ouer the



earth, which is here repreſented by D: and now I ſee that B, which is right ouer D, is much neerer to it then A, or C, or anie other point in that flat plain forme, which is ſet to repreſent the flat ſkie.

Maiſter.

Now then what will Lactantius ſay, or any man for him: doth this heauen moue or not?

Scholler.

We cannot denie that which we may ſee with our eies, that both the ſun, the mooone, and all ſtarres doe moone euery houre continually.

Maiſter.

Yet peraduenture he might ſay, as ſome other like contemners of philoſophie haue ſaid, that the ſtarres and Planets doe moone in the ſkie, as fiſhes doe ſwimme in the water: and that they go forward though the heauen ſtand ſtill.

Scholler.

I remember I haue heard of that ſaying, and that a famous writer of late doth maintaine that opinion.

Maiſter.

What will they ſay then, doth keepe the ſtarres in ſuch a iuſt order and equalitie of diſtance, which neuer altered any one whit, ſith the beginning of the worlde? Is it poſſible that the ſtarres ſhould moone in the ſkie as fiſhes doe ſwimme in the water, or as birdes flie in the aire, as ſome terme it, but that the Starres muſt ſtraggle in their courſe, as the fiſhes doe, and as the birdes alſo doe?

Scholler.

I haue seene both fishes in the water, and foules in the aire, to keep a marueilous certaine course in their flying and swimming, and namely fishes that go in sculles, as herrings commonly doe, and other fishes diuers times, and wild-geese also and stockes in their flying, whereof I haue often mused.

Maister.

You may often see such notable sights: yet if you marke them, you shall see much alteration in their flying, as well as in the swimming of the fishes: whereby you may thinke their order not to be constant, but sometime one flieth a little faster, and another a little slacker: and somtime they swarue on the one side, and somtime on the other: But were it not a fond imagination, to thinke that starres doe flie and follow one guide as byrdes doe, and in 5000. yeare space to keepe their places so precisely, that they varie not one minute of a degree?

Scholler.

Indeed it were marueilous, and so are all Gods workes.

Maister.

The Milky way called of the Greekes, Galliaxia,

Yet is there one inuincible reason against that opinion, gathered out of the figure of the Milkye way in heauen, which many men in England doe call Watling street, cõparing it to one of the great high waies in England if is called Watling streete. This Milkeway, if it serued for none other purpose, yet doth it seeme worthy the noting, for the exact confutation of the said opinion: and for that cause it might seeme to be made by God, which hath wrought manie meanes to leade men vnto trueth. This way is in the skie it selfe, as all men haue confessed, and their eies doe testifie, and the starres that be in it are alwaies seene to keepe their places in it: so that it must needes followe, that the same way doth moue with the starres, and then consequently the skie must needes moue also.

Scholler.

Yet it may be said, that the stars which be in it doe moue alwaies so certainly in it, that it may seeme to moue, although it stand still.

Maister.

Did you euer marke the same Milke way?

Scholler.

Yea verily, and that often.

Maister.

And did you perceiue in it anie boughtes, corners, partitions, or such other like markes, whereby you might know one part of it from another?

Scholler.

That haue I done also, insomuch that in some places it seemeth to be diuided into two waies.

Maister.

Maiſter.

That is true. And thinke you if the ſtarres did moue in it, and it ſtand ſtil, that theſe ſtarres which now be by the partition of thoſe branches, muſt not within foure or fiue houres be paſſed farre from that place?

Scholler.

It ſhould ſo follow, yet that is not ſo: for I haue marked the contrarie oftentimes, that they keepe thoſe places ſtill.

Maiſter.

Then do not the ſtarres moue from their places, but as thoſe places moue with them.

Scholler.

It appeareth now too plaine to be made doubtfull any more.

Maiſter.

I will yet prooue it better. Did you euer marke any notable place of that milke way at the beginning of the night in the eaſt, or in any other coaſt of heauen?

Scholler.

Yea forſooth.

Maiſter.

And haue you marked whether that place hath gone any further weſtward that night?

Scholler.

I haue marked it well, and haue perceiued that it hath moued a great way from his firſt place: and whoſoeuer liſteth to trie it, let him at ſixe of the clocke in the deepe winter marke any notable places in it, and at tenne of the clocke the ſame night, he ſhall perceiue it to haue gone weſtward more then a quarter of the ſkie.

Maiſter.

Your words are true, meaning a quarter of the ſkie aboue your horizont: and by this you ſee, it cannot be auoyded, but that the ſkie doth moue aſwell as the ſtarres.

Scholler.

It is moſt manifeſtly prooued, ſo that Lactantius himſelfe cannot deny it, vnleſſe he will deny that his owne ſenſes may iudge in ſenſible things.

Maiſter.

Then if the heauen be flat, as he doth imagine it to be, and it doth moue weſtward, as al mẽ do ſee, either he muſt ſay that the ſkie is infinit in length, and that we neuer ſee any part of it againe, after it is once paſt our ſight, and thereby affirme, that there be infinit many ſunnes, and as many moones, and an infinit number alſo of all other planets, and of all ſeuerall kind of ſtarres, or elſe he muſt declare which way the ſunne, the moone, and the other ſtarres

do come into the east againe.

Scholler.

He cannot say that they come backeward the same way that they went forward, for then we should see them in their returning: and to say trueth, there can be none other forme of mouing, but in round forme, that may bring them into the east againe: but peraduenture he may say, that though the skie be flat, and plaine in forme, yet it hath a round motion.

Maister.

Some other man may say so: for he thinketh the contrary, as his wordes import, for in reproouing Astronomers, he saieth: *Ex motu syderum opinati sunt cœlum volui*: By the mouing of the starres they imagined that the heauen doth turne round: by which words he seemeth to meane that the starres moone, but not the skie.

Scholler.

That is fully improoued before.

Maister.

If it were not, I might reason with him thus: Seeing he affirmeth, as reason inforceth him, that the starres do moone, and will not confesse that the skie turneth round, then (as I declared before) one part of the skie which is ouer our heades, is nearer to the earth then both the endes be.

Scholler.

That appeareth plaine, except hee would say against all reason, that the earth were as large as the skie.

Maister.

An argument against the flatnesse of the skie.

The maior or maxime.

Though he would say so, my reason shall proceede in full strength, sith some partes of the skie by his meaning must needes be further from vs then some other. Therefore I frame my reason thus: All things that men can see, seeme greatest when they be nighest vnto men, and the further they be from their sight, the lesser they shew.

Scholler.

I thinke no man so childish to deny that: for euery houre our sight doeth approoue that it is so: if we see a man a farre off, he seemeth no bigger then a little childe: and a great ship farre in the sea, sheweth no bigger then a crow sometimes.

Maister.

The minor.

Then taking that for a maxime in argument, I anner this minor, that the starres mooning in that imagined flat skie, are most nighest to vs, when they be ouer our heades, and they are furthest from vs, when they be in the east or in the west: wherefore I inferre the conclusion, that the starres must seeme greatest when they be ouer our heades, and they must seeme much lesser when they be in the east or west.

The conclusion.

Scholler,

Scholler.

This concluſion is plainely falſe: for our eies do teſtifie the contrary, ſith alwayes the ſunne, the moone, and the ſtarres do ſeeme greateſt at the riſing in the eaſt, and at their ſetting in the weſt. And they ſhew ſmalleſt, when they be nigheſt ouer our heads.

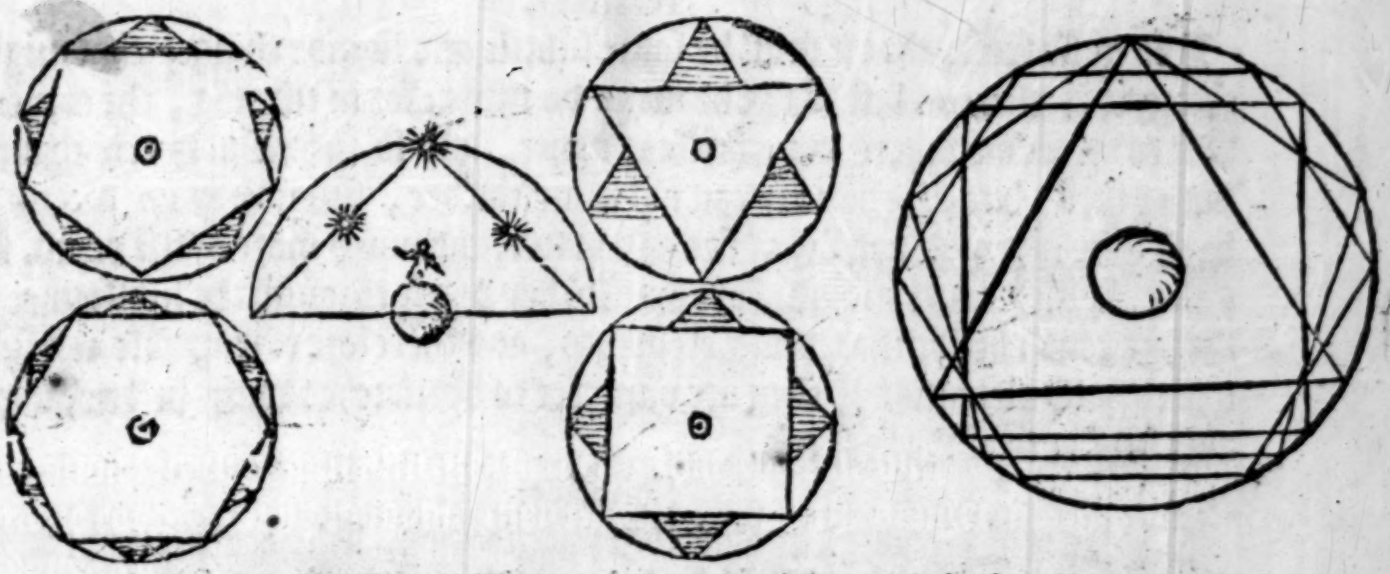
Maiſter.

If the concluſion be falſe, and the argument good, as Lactantius can not controll it, then I may obiect to him his owne rule: *Neceſſe eſt falſa eſſe, quæ rebus falſis congruunt.* It cannot be choſen but thoſe muſt be falſe ſentences that do agree with falſe matters: and ſo muſt they needes be falſe premiſſes that do inferre a falſe concluſion.

Scholler.

In good faith I thinke neither Lactantius, nor any man elſe is able to auoyde this reaſon, except he wil auoyde that fond opinion of imagining a flat ſkie, and the ſtanding of the ſame vnmoueable: yet if any man would ſay, that the heauen were ſquare, or of any other forme of diuers angles, as here you ſee many varieties in theſe figures, how might I aptly reproue their

Another reaſon by auoyding of emptineſſe which nature can not beare.



opinion, if they will affirme further, that the ſkie with ſuch a forme doth moue round: for by ſo ſaying they might auoyde the danger of this laſt inconuenience.

Maiſter.

While they might ſeeme to auoyde one danger, they fall into an other: as for a proofe: I turne thoſe figures round, whereby indeed it appeareth, that euery part of them keepe ſtill their owne diſtaunces vnchangeably from the centre, but yet is one part more neare the centre then another part is, and euery part in their turning ſeemeth to deſcribe a circle about the centre, each circle in bignes according to the diſtance of that part whereby it is deſcribed, and ſo the greateſt circles are made by the extreame angles of euery figure.

Scholler.

All

All that is easily perceiued, at the first sight in turning the figures about.

Maister.

Then if the heauen be cornered, it may haue no lesse roome to moue in, then the compasse of the vttermost circle doth require.

Scholler.

That appeareth certaine, for elseit would stay by those corners, or breake the corners in the turning, whereof neither is to be fantasied but of fooles, whose thoughts are pardonable in all those that refuse not their common fellowship, but not in other, although for their worthinesse they might be Wardens of that company.

Maister.

Then if for their motion they require so large a circle, as may compasse their corners, there appeareth void roome against euery side, in which roome what shall be set to auoide emptinesse, which nature cannot beare?

Scholler.

Let them answere that like that fantasie, for I can imagine nothing, except I should name Ayre, but that by his nature cannot ascend so high.

Maister.

You gesse well, that it must be some subtile and liquide thing, that might change his place as fast as the heauens do turne: for in turning, the corners will come anone where emptinesse is nowe, and so successiuely ech change with other: but ayre you say can not come thither, sith it may not ascend so high: the like may you say of fire and water, and much more of the earth. Againe, if they could ascend, how should they pierse through the substaunce of the heauens? beside that, being elements, and therefore corruptible and subiect to daily alterations, they are vnmeete to be matched with the Vnchangeable substance of the heauens.

Scholler.

This is reason enough against that imagination, sith nature can not suffer it to be empty, and nothing else but part of the skie can supply it.

Maister.

The fifth reason for apt mooning.

Consider yet further: sith the motion of heauen of all other must be iudged the most swiftest, which in foure and twentie houres doth run so large a race, that is manifold greater then the compas of all the earth, so that euery houre it runneth many thousand miles, doth not this swift motion require that forme, which is of all other most apt for mooning? and doth it not repugne to such formes as be full of corners, and therefore vnapt to moue swiftly or vniformely?

Scholler.

It appeareth plaine madnesse to dreame once the contrary.

Maister.

Maiſter.

Then all men know, that as cornered bodies be moſt vnapt to runne, ſo is a round globe moſt apt of al other.

Scholler.

Euery common Turner can ſkill in that reaſon, and knoweth that a little altering of the one ſide, maketh the bowle to runn byas-wiſe.

Maiſter.

If the reaſon be ſo plaine that common artificers can ſkill of it, it were too great a follie for learned men to doubt of it.

Scholler.

They that doubt of it, neuer weyed their opinion with any reaſon, as I may thinke, for theſe reaſons ſuffice to perſwade any man.

Maiſter.

Yet once againe weigh this for the forme of heauen, ſith it incloſeth all things, and is the greateſt of all other, were it not meete that it ſhould haue the greateſt forme which is moſt large and apt to compaſſe and incloſe all other? The fourth reaſon for capacitie.

Scholler.

It is both meete and neceſſary alſo.

Maiſter.

Then is it well-knowen of yong ſchollers in Geometrie, that as of al flat formes of like circumference, the circle is the greateſt, ſo of all ſound formes of like circuite, the globe is moſt largeſt, and therefore moſt apteſt for the forme of the ſkie, which incloſeth all things that man can ſee.

Scholler.

I might be aſhamed to demaunde any more proofe for the roundneſſe of heauen or his circulare motion, yet are the reaſons ſo pleaſant, that I delight much in the hearing of them, and therefore can be content to imploy as much time in hearing them, as you thinke good to beſtow in framing them.

Maiſter.

I could occupy you to a great time: but I thinke it not beſt to ſtay thereon too long, ſith we haue many other matters to proue, and at other times we may talke hereof againe. Theſe reaſons which you haue heard do proue, not onely that the motion of heauen is round, but alſo that the round forme doth beſt agree to the ſkie, for largenes of capacitie, for aptneſſe in mouing, for auoyding of emptineſſe, and for the iuſt appearance of the ſtarres in vniforme bigneſſe, which I thinke ſufficient for this time.

Scholler.

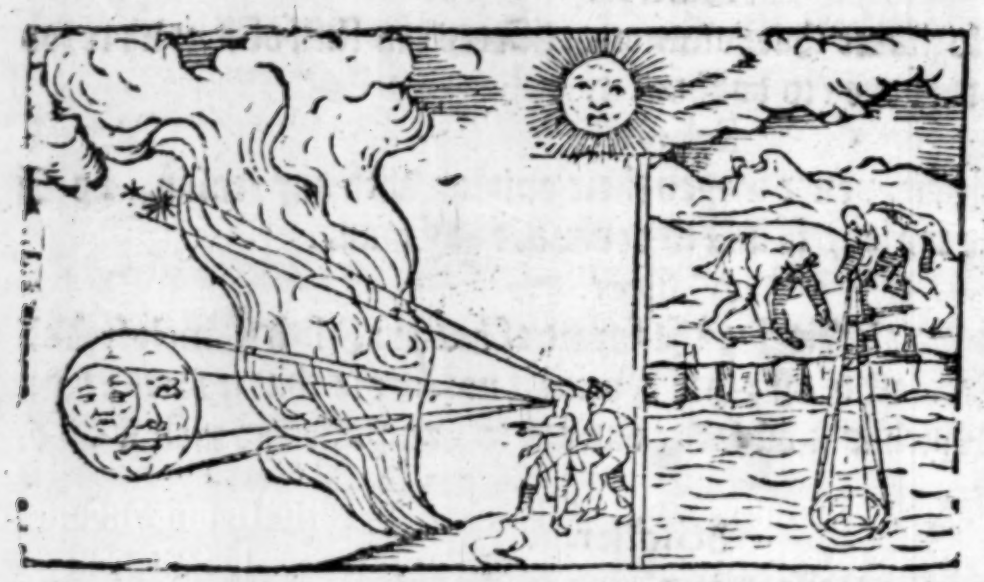
There be two things by the way that I deſire much to heare more largely declared: the one is for the appearance of ſtarres, which ſeeme greateſt at their riſing and ſetting: the other is, for the auoyding of emptineſſe, which

as I haue often heard) so would I gladly once vnderstand.

Maister.

The first of them appertaineth to perspectiue, and the second vnto naturall philosophie, so that both doe require another place and time: yet because I haue alleadged it for this present matter, although the reasons why it is so, may not well here be repeated, yet that it is so, shall be briefly declared. In a

All things shew great through vapors or mist.



mystie morning as you walke, al things that you see, seeme greater through the myst, then indeed they be: a penny in the water seemes broader then it is, and the deeper it lieth, the greater it appeareth: so the sunne and the moone and all other starres being nigh to the earth, do shew through the vapours that ascend from the ground, and therefore appeare greater then they be: and if the vapours be many, the starres shew the bigger: the cause is, the interruption and reflection of the sight beames by the vapours and the water: and like is the cause in seeing through glasse, which occasioned weake sights to seeke aide of spectacles.

Scholler.

Many vse that aide that know not the reason thereof.

Maister.

Nature abhorreth emptinesse.

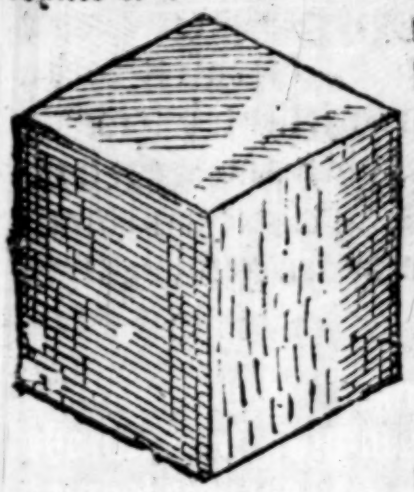
So many draw water at a plumpe, that know not the cause why the water doth ascend, which is onely natures worke to auoyde emptinesse. And many men vse bellowes to blow the fire, which know not the reason of their first inuention, and therefore cannot mend them if they be hard to draw: many men also draw waters by fountaines higher then the spring, yet few of them doe knowe what is the reason of their worke, and therefore few can amend it, if the fault bee any thing doubtfull. A great number of other like thinges coulde I shewe, where natures abhorfulnesse to permitte any emptinesse, doeth cause straunge effectes, in thinges that are vsed of many men, and well knowen of few menne. But as it appertaineth not to this place to discourse largely in those matters, so another time shal serue for them. Now let vs proceede in our purposed attempt, to see what proofes I can bring for the roundnesse of the earth: wherein I will beginne with a distribution dis-

Diuers opinions of the forme of the earth.

iunctiue,

inuetiue, containing many opinions touching the forme of the earth: and ech of them wil I ſubſtantially improue, ſaue that onely which affirmeth it to be round, and that wil I ſo fully approoue, that I doubt not but you ſhall think your ſelfe fully ſatiſfied. Some men conſidering, that as for the ſkie no forme was ſo meete as a round forme, becauſe of his ſwift mooning, ſo for the earth which ſtandeth ſo ſteadily, they iudged no forme ſo meete as a cube forme, which they eſteemed moſt ſtable of al other: and therefore many auncient philoſophers by the forme of a cube ſecretly ſignified conſtancie and ſtableneſſe: and contrarywiſe by the forme of a globe they expreſſed changeable alteration and continuall mooning.

Why fortune is pictured ſtanding on a globe.



Why dice be made in cubiſh forme.

Diuers fortune.

Scholler.

That I may perceiue by the placing of Fortune on a rolling globe, in token of her inconſtancie and voluble changing. And therefore haue I often fantaſied, that dice, which is the image of Fortunes inconſtancie, and ſerueth onely for fortunes playes, might beſt haue been made in forme of a globe, for they are as vnconſtant as fortune her ſelfe.

Maiſter.

There ſeemeth in Fortune two diuers natures, the one is light and alway flickering, the other is heauy, and therefore more ſtable, ſo that oftetimes we ſee them that haue a light and pleaſant fortune, as lightly leeſe that they lightly gained: but where heauy fortune ſetteth her foote, ſeldome can ſhe be remooued, her ſteppes are ſo ſtayed: but to expreſſe more exactly the nature of the cube reſembled in the dice, both in forme and in effect, you ſhall marke well the meaning of that olde prouerb: *Iacta eſt alea*, The dice is caſt, or the lotte is drawen, or fortune is paſt, by which ſaying is declared, that the thing that is once done, can neuer againe be vndone, although it may be altered, and ſo conſtancie in that appeareth moſt certaine: for as your chaunce on the dice being once caſt, you muſt be content to ſtand to it: ſo fortune when it is paſt, can not be altered. And that is the cauſe why all men vſe to ſay, when they expreſſe their ſtay in liuing: ſuch is my fortune. Yet many learned men put difference between changeable chance, and ſtable fortune, calling the firſt *Fortuna*, and the other *Fatum*: ſo that deſtiny is ſtable, though fortune change right often. But thus I forget our purpoſed intent, with ſo many digreſſions of other by-matters.

Scholler.

I found no fault, nor thought no time loſt, ſith the matter is pleaſant and ſomewhat to our purpoſe.

Maiſter.

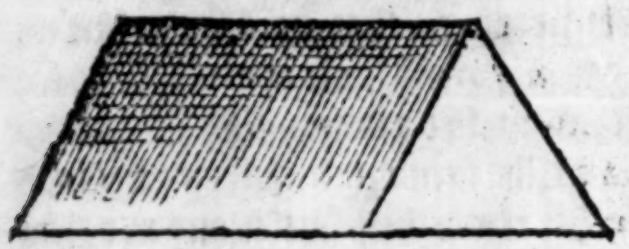
Well, this was their imagination that thought the earth to be of a cubike

The second opinion.

forme, for that they iudged it to be the most stedfast forme.

Then another sort deuised a three cornered forme like the ridge of an house where the one side lieth flatte, and the other two leane aslope. And this forme they iudged better for two causes: first they thought that it was more steadie then a cube forme, because it hath a broader foote, and a lesser top: secondly for that they thought it a more apt form to walke on, and more agreeable to the nature of the earth, where sometimes there riseth high hilles, and sometime againe men may see great valleyes descending.

A Ridge forme.



Scholler.

This imagination is grosse enough.

Maister.

And so grosse is the iudgement of them that follow not, or search not for true reason, but content themselues with a light conceiued fantasie.

Scholler.

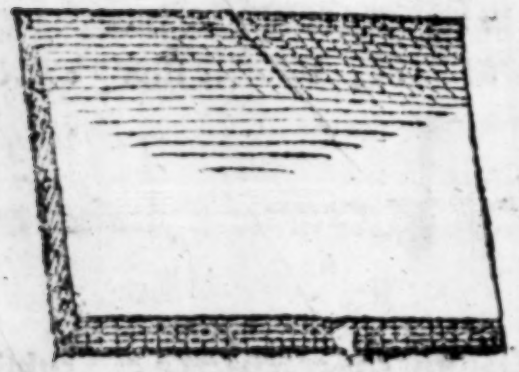
And in this they be deceiued, that they account this forme more apt to walk on, for the flat of the cube is plainer, and therefore more apt to walke on, then is a slope ground.

Maister.

If the first part of the earth were onely inhabited, then would it appeare so indeede: but if you goe any further, then haue you vnapt plainesse to walke on in their imagination, which go so downe right, that they doe feare falling. Againe, they thinke this ridge forme meetest for the standing of the sea, and for running of riuers: for in the first forme, if the sea should rest on the vppermost plaine, then would it ouerrunne all that plaine, and so flowe ouer all the earth: whereas in this second forme it might rest about the foote of the earth, and yet the slope rising will not permitte it to ouerrunne all the earth. And so for riuers, if there be no slopenesse (as in a cube there is none) then can not the riuers runne well.

The third opinion.

A plaine flat.



A third sect thinking to amend these both, imagined the earth to be plaine and flatte: for so they fantasied that it would rest most steadily, and so was it very easie to walke on.

Scholler.

We are more beholding to those men, for deuising our easie walking, then we are bound vnto them for their wise doctrine.

Maister.

Maister.

The fourth sect, fearing least by this opinion they should leese the Sea and all other waters, imagined the forme of the earth more apte to holde water, and deuised it hollow like a boll.

Scholler.

Those men were verie studious for saying of water, more then they were for framing of their wits.

Maister.

Yet this vaine folly did seeme to them great wisedome.

Scholler.

Saue that I doe credite your report, I would neuer haue thought, and much lesse haue beleeued, that euer anie such mad imaginations had been phantasied of anie men.

Maister.

Who listeth to see the monstruous opinions of such dreaming doters, may reade them often touched in Aristotle his naturall bookes, and abundantly in Plutarch his Booke *De philosophorum placitis*. And in Galene and Eusebius in bookes of the same matter peculiarly written. But these 4. opinions which I haue here rehearsed, are briefly noted in the first booke of Cleomedes sphere, though not in like order: and saue that in the second opinion I iudge his print corrupt, and that for *Pyramoeides* I doe reade and translate *Prismoeides*: as it may well be gathered by his owne confutation, which will not agree so well for confuting all steeple formes or spire formes, but as mens iudgement ought to be free, so if any man list to followe the print, I will not withstand him.

Scholler.

Although some of these opinions are so grosse that they need no confutation, yet I pray you repeate the confutations that Cleomedes doth vse.

Maister.

I am well content, and better pleased to alledge them in his owne name, then to ascribe them to my selfe, for diuers causes. First hee beginneth with the third opinion, and reprooueth it thus. If the earth were flat and plaine, then should all nations haue one horizonte: for in a plaine flat forme, there can be no iust cause of alteration of the Horizont.

Scholler.

That followeth most certainly.

Maister.

Then must the Sunne and Moone and all other starres rise to all people,

when they rise to any one, and so must they set (eche one in his course) to all men at one instant.

Scholler.

That will follow also.

Maister.

If the Sunne rise to all men at once, and set likewise at one time, then must the day beginne to al people at once, and al nations must haue night at one time precisely.

Scholler.

That is false, as al men confesse. for at Ierusalem (which is wel known) it is day three houres sooner then with vs, and so it is night sooner by three houres also. But Calecut (as learned men affirme, and trauellers thither, doe confirme) it is day sixe houres sooner then with vs, and it is night sixe houres sooner to them againe then to vs.

Maister.

Your sayinges are true if they be well taken: but and if this conclusion be false, as it is indeed, then must that opinion be false, whereof this conclusion is inferred.

Scholler.

So doth it well follow, and is fully prooued.

Maister.

One strong reason for the varietie of houres is gathered by the eclipses duely obserued, and namely of the Moone: for as it happeneth at one instant of time, so is not one houre to all nations. As for example: This yeare of 1556, the eclipse of the Moone shall be with vs the 17. day of November at 3. of the clocke in the morning, and to them of Calecut it shalbe at nine of the clocke in the morning: yea wee shall see the moone in the South-west, and they shall not see her at the same instaat, for shee will be to them vnder the horizonte in the Northwest. Likewise in the yeare of 1562. there shall be a great eclipse of the Moone with vs, which shal endure aboue three houres and an halfe, and yet shal they at Calecut see no part of it, by reason that the moone shall be farre vnder their horizont before that eclipse beginne. And in like maner this last yeare 1555. was there a great eclipse of the moone the fift day of June, at three of the clocke in the morning, yet in Calecut there was none eclipse seene then, for the moone was set vnder their horizont two houres almost before the eclipse began. But in the yeare of 1551. when we had the eclipse of the moone at 9. of the clocke at night, the 20. day of Februarp, they at Calecut saw that eclipse at three of the clocke in the morning the next day, as the Portingales ý were there can testifie. Whereby it is manifest, that their horizont doth not agree with ours, and therof doth it follow that the earth is not flat. But now to turne to Cleomedes again, (vnto whose wordes I haue added but the examples of the eclipses) his se-

Examples of Eclipses.

cond

cond reason against the flatnesse of the earth, is this.

If the earth were flat and plaine in forme, then the Pole must needes appeare at one height to al the partes of the world, and the arctike circle (which incloseth the stars that neuer set) should be but one to al nations. But both these thinges appeare plainly false: for as vnto vs about London the Pole is not fully 52. degrees high: so if you go northward, you shal find the Pole to rise higher and higher, til it be fully nintie degrees high. And in going southward, the eleuation of the Pole waxeth lesser, til you come to the middle of the earth vnder the equinoctial, where the pole is of no height, but is equall with the Horizont. Also in all these places, you shall haue seuerall arctike circles.

An other reproofe of the flatnesse of the earth.

Scholler.

That must needes follow the diuersitie in the eleuation of the Pole, as it hath been sufficiently declared before.

Maister.

As the first improbation doth reproue the flatnesse of the earth betweene East and West, because it regardeth chiefly the rising and setting of the sun and other starres, and their course betweene East and West: so this second confutation improoueth the opinion of plainnesse betweene South & North. So doth it follow, that the earth is flat neither one way nor other, but both waies hath some certaine rising, which anon I wil proone to be a iust roundnesse.

A third reason is alledged by Cleomedes, touching the equalities of daies to all nations, which should of necessitie follow if the earth were flat, and all people had one Horizont, but because it is so little disagreeable from the first reason of one Horizont, and one time of rising and setting of the sun, I haue ioyned them both in one, as before it doth appeare. These three reasons are plaine enough.

The third confutation.

The fourth reason which Cleomedes doth make, is not so easie: yet is it as certaine as any of the other: and therefore I will shewe you what it is, seeing you desire to heare his owne argumentes, although I determined before to alleadge such reasons onely, as might appeare easie to vnderstand.

Scholler.

If it be not ouermuch obscure, it may please you to declare it in the most plainest forme ye can.

Maister.

I will only alter his order in the propositions, adding that which is not easie to be gathered, to make it the easier to your vnderstanding. This is it.

If the earth were plaine, it shoulde follow, that the whole diameter of the world from one side of the skie to the other, should be but 100000. furlongs,

that

The fourth cõfutation of the plainesse of the earth.

it maketh 12500. miles, which saying appeareth so absurd, that no man will graunt it: but if any man would doe it, this argument following shall confute him. First therefore I reason thus: If the earth be plaine, then all places of the earth are as farre asunder as their zeniths or verticall points be in heauen. This maxime must I adde vnto Cleomedes, to make his reason the more plaine.

Scholler.

But this maxime doe I not vnderstand, wherefore I beseech you both to prooue it, and declare it.

Maister.

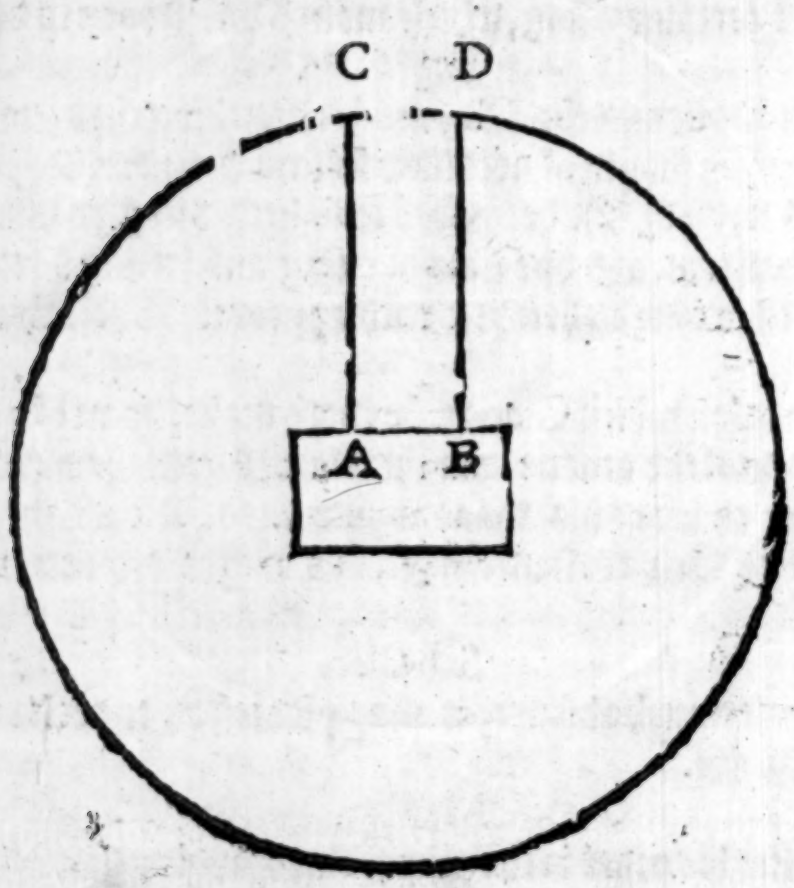
I am content. You knowe by the former Treatises, that the zenith is the point right ouer the head of any people, whose zenith it is: whereof it must follow, that euery diuers place in earth, must needes haue a seuerall zenith in the skie.

Scholler.

That is plaine.

Maister.

Then imagining the earth to be flat, the lines that do ascend from any two places vnto their zeniths in the skie, must needes be paralels, as heere in this picture doth partely appeare: for if the circle be set for the skie, and the



flat square within it for the earth, then take 2. places in the earth, as A and B, the zenith to A is C, and must needs be right ouer it, and therfore the line

that

that is drawne from A to C, muſt be a iuſt plumb line, and perpendicular to the flat earth. And likewiſe the zenith to B is D, which muſt needes be right ouer it, and therefore the line that goeth from D to B, muſt of neceſſitie be a perpendicular and plumbe line to the flat earth alſo. Then if both thoſe lines be perpendicular to one flat plaine, or to one line ſtanding for that plaine flat, all the angles that they both doe make with the third line A B, muſt be right angles, according to the definition of a perpendicular line. Nowe if all their angles be right, then are they all equall according to the fourth grauntable requeſt in the ſecond booke of the Pathway, that all right angles be equall eche to other. And if all their angles be equall, then muſt their match angles be equall, of force: wherby it doth followe according to the 18. Theorem of the ſecond booke of the Pathway, that theſe two perpendicular lines be paralelles, ſeeing that on two right lines, as A C and B D, there is drawne a third right line A B, croſſewaies, and maketh two match corners of the one line, equall with the like two matche corners of the other line.

Scholler.

Hereby I haue not only gotten the vnderſtanding of your proofe, but alſo I perceiue a farther vſe in the Theorems of the Pathway, then I knewe before.

Maiſter.

I will proſecute my proofe. With thoſe two lines be paralelles, and equally diſtaunt, then is there as much ſpace betweene A and B, as there is betweene C and D.

Scholler.

Thus is your maxime ſufficiently prooued, and fully declared: for A B betokeneth the diſtance of the two places in earth. and C D, ſtandeth for the diſtance of their zenithes in the ſkie.

Maiſter.

Now therefore will I returne to Cleomedes argument. They that dwel at Lyſimachia (in Greece) and they that dwel at Syene (in the ſouth part of Egypt) haue between them in diſtance 20000. furlongs, (which is 2500 miles) wherfore it muſt follow that their zeniths in the ſkie be no farther aſunder, ſeeing they be limitted by 2. perpendiculars equally diſtant: but it is wel known by good proofe of inſtrumentes, that Syene is vnder the Tropike of Cancer directly, and Lyſimachia is vnder the head of the North Dragon, which two places in the ſkie are iuſtly prooued to be aſunder the 15. part of the whole compaſſe of heauen, that is the fift part of the diameter of the ſkie. Wherefore if 20000. furlonges be the fift part of the diameter, the whole diameter muſt be but 100000. furlongs: and the whole compaſſe of the ſkie muſt be but 300000 furlonges, and of theſe furlonges it is prooued, that the earth containeth in compaſſe 250000. So is the heauen little bigger then

the earth in compasse. Which absurditie may easily be confuted by the sun, which in comparison to the skie, is a very little part of it, and yet is bigger then the earth many fold: whereby any man may see what absurdtie followeth that opinion, to thinke that the earth is flat.

Scholler.

I doe meetly well understand this reason, but I shoulde better haue conceiued it, if I had knowne the two places which hee alledgeth for examples sake.

Maister.

A like reason

Then will I for your pleasure make the like argument by example of two places which are better knowne to English men. You know the castle of Arundell,

Scholler.

The name is anncient and famous.

Maister.

And Newcastle vpon Tine is well knowne to you also.

Scholler.

So is it.

Maister.

Arundel castle. Newcastle.

To go the next way betweene these two places it is 270. English miles. And the Zenith of Arundel castle (which is the iust point of the latitude of it) is 50. degrees and 30. minutes, as once I remember I took note of it in riding that waies. The Zenith also of Newcastle is from the equinoctiall 55. degrees: so is the difference betweene their zenithes 4. degrees and 30. minutes. Now (as I haue declared before) If the earth be flat and the perpendicular lines bee paralelles and equidistant that go vp from these two places to their zenithes, then is 4. degrees and 30. minutes, iust equall in quantitie to 270. miles.

Scholler.

That is true, as it is proued before in the third treatise.

Maister.

You are farre deceiued: it is declared there, that 270. miles in earth, must answere in proportion to foure degrees and an halfe, and not that they are equall together.

Scholler.

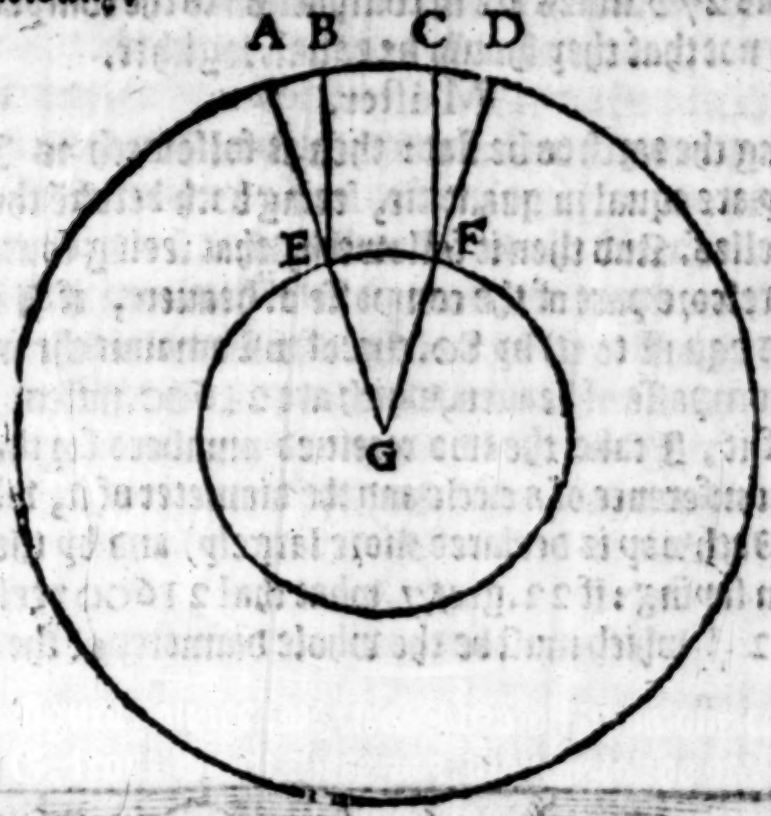
I perceiue mine owne negligence in marking the propertie of speeche. I should haue said, that as foure degrees and an halfe is the eight score part of the whole compasse of heauen, so 270. miles is the eight score part of the circuite of the earth,

Maister.

That is true: but yet these two partes are as farre vnequall in quantitie

as

as heauen and earth are vnlike in their compasse, wherefore to the intent that from henceforth you shall not mistake it againe, I will by lineary demonstration set before your eies the declaration and difference of them both more plainly then curiously.



Here in this figure you see two circles drawn vpon one centre, their cõmon centre being G, from which there are drawne to the vttermost circle two right lines G A, and G D, these lines doe crosse the lesser circle in 2. points E and F, fro which two pointes I haue drawne two paralelles, vnto the circumference of the greater circle, which two paralelles be B E, and C F. Now may I say, that because these two circles be made vpon a commõ centre, and two lines drawne from that centre to the circumference of both the circles, because A G D is one common angle in them both, therefore are there archlines inclosed betweene those two right lines like in proportion.

Scholler.

I perceiue it wel: so that if the arch line A D in the greater circle, be the first part of it, then is E F, the archline of the lesser circle], the first part of his owne circle, in likemaner: but yet that arch of the lesser circle is not so great as the like arche in the bigger circle.

Maister. Then what say you of the arch B C, in comparison to the arch E F, which both arches are betweene two lines paralels?

Scholler. They must needs be equall, seeing there is iust as much distance betweene E F, as there is betweene B C.

So may you nowe perceiue what difference it is to say, that two arches of two seuerall circles, are like in proportion: and to say that they are equall in quantitie.

Scholler.

Now I perceiue it plainly, that although foure degrees and an halfe (as your former reason did import) be like in proportion to the whole circumference of heauē, as 270. miles are in comparison to the compasse of the earth: yet it followeth not that they should be equall togither.

Maister.

But supposing the earth to be flat: then it followeth as I haue declared before, that they are equal in quantitie, seeing both betokē the distance of one couple of paralelles. And then it followeth, that seeing foure degrees and a halfe is the fourescore part of the compasse of heauen, if I multiply 270. miles (which is equall to it) by 80. therof wil amount the number of miles that make the compasse of heauen, which are 21600. miles. Now to knowe the diameter of it, I take the two receiued numbers for the proportion betweene the circumference of a circle and the diameter of it, which are 22. and 7, (as in the Pathway is declared more largely) and by the rule of proportion I worke in saying: if 22. giue 7. what shal 21600 yeeld: and there amounteth 6872 $\frac{8}{11}$ which must be the whole diameter of the skie, if the earth were flat.

270
80
21600

Scholler.

That is too great an inconuenience for any man to affirme: for thereby I see it would follow that if we go any way from our owne countrey, 3436. miles, we shal come hard to the skie, which is too childish a fantasie, sith not only reason, but daily trauel declareth the contrary. Again I remember that in the third treatise you declared that the earth was so much in compasse, which must needs be many fold

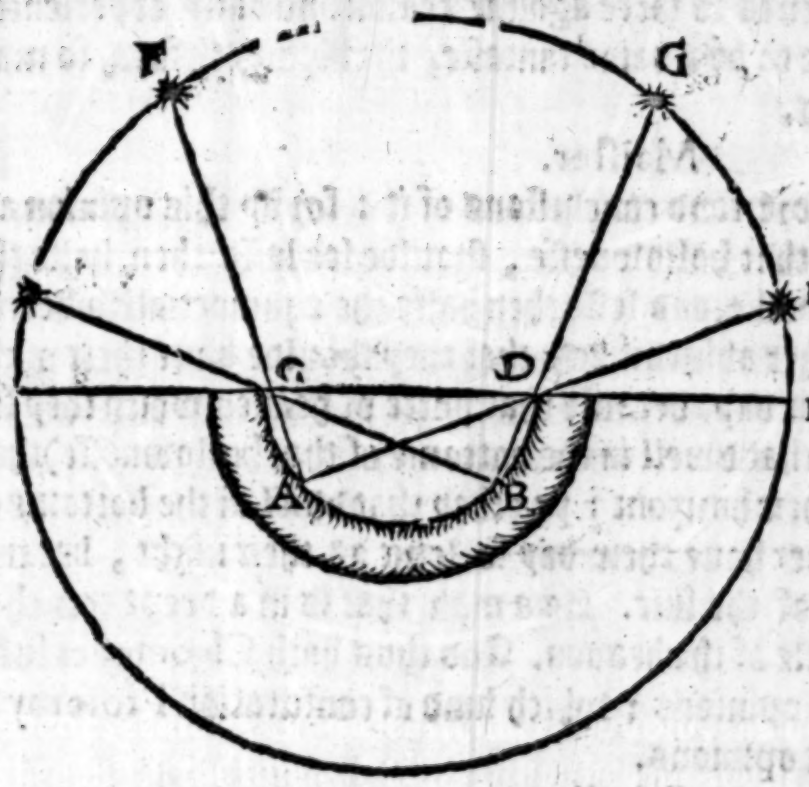
22 7
21600 6872 8/11
21600 X
7
151200
X 7 2 1
2 9 6 6 6
X 5 X 2 0 0 (6872
2 2 2 2 2
2 2 X

leſſe then the heauens, which are ſo farre diſtant from the earth on euery ſide.

Maiſter.

Thus are all Cleomedes reaſons againſt the flatneſſe of the earth fully alleadged, and ſomewhat largely declared: now will I proceede to the confutations hee vſeth againſt the other opinions, following his owne order: wherefore next followeth the confutation of them which ſay that the earth is hollow like a boll. Againſt whoſe fantaſticall imagination he reaſoneth thus: If the earth were hollow as a boll, then ſhould the ſunne, the moone, and all ſtarres in their riſing appeare ſooner to them that dwell in the weſt, then to them that dwell in the eaſt: which thing is contrary to daily experience. For declaration of which ſaying by lineare demonſtration I thinke good to draw

The confutation of the fourth opinion



a figure, wherin you maie aptely ſee the force of his reaſon. The vttermoſt circle of the figure doeth repreſent the ſkie, and the innermoſt halfe circle ſtandeth for the imagined hollowneſſe of the earth, and the halfe rundlet A B repreſenteth the maſſy ſubſtance of ỹ earth, the right line K L, expreſſeth the diameter of the world, and therfore the right horizont of the earth, K being the eaſt, and L the weſt. Now for explication of Cleomedes reaſon: If the earth were hollow, as here the forme of it is drawen, then when the ſunne is riſen, in the eaſt about E it woulde appeare to them that dwell in the weſt by B, and not vnto them that dwel in the eaſt by A, for the brow of the hollow ground by C doth hide the ſunne yet from them, ſo that he muſt aſcend as high as F, before they that dwell in the eaſt by A may ſee him. Againe, when the ſunne goeth downe, by this opinion hee ſhould ſet to them that dwell in the weſt by B, as ſoone as hee came to G, by occaſion of the browe of the ground by D. and yet they that dwell in the eaſt by A. ſhould ſee him a great while longer: for that brow of ground by D. will not yet hinder their ſight, vntill he be deſcended as lowe as H. So ſhoulde they that dwel in the weſt ſee the ſunne ſooneſt in the morning, and they that dwel in the eaſt ſhould ſee him lateſt at euening.

Scholler.

This thing is so false, that euery childe knoweth the contrary.

Maister.

Another reproofe of the same opinion.

Yet of that opinion doth there follow further inconuenience, as Cleomedes doth shew: for by this fantasie, they that dwell in the south shoulde see the north pole higher aboue ground, and so should haue a larger arctike circle, then they that dwell in the north, as by the same figure it may be declared.

Scholler.

I perceiue it well: for if I make K to be the south, and L the north, then it appeareth in this forme of the earth, that they which dwell in the south by A. may see as lowe as H: and they that dwell in the north by B, can see no further north then G: which is so farre against reason and daily experience, that it must needes appeare to be a vaine fantasie, that bringeth forth so mad and monstrous conclusions.

Yet another confutation of the same opinion.

Maister.

Yet doth there follow more fond conclusions of it: for by this opinion all nations that dwell within that hollownesse, shoulde see lesse then halfe the skie, lesse then halfe the zodiake, and lesse then halfe the equinoctiall: whereof it would follow (beside other absurdities) that they shoulde haue their night commonly longer then their day, because that parte of heauen which they see is lesse (especially to them that dwell in the bottome of that hollownesse) then that part which is vnder their horizont: yea they that dwel in the bottome of that hollownesse, can neuer haue their day so long as their night, because they see so little a portion of the skie. As a man that is in a deepe trench or in a pitte, can see but a little of the heauen. And thus hath Cleomedes sufficiently confuted those two opinions: which kind of confutation Ptolomy vseth also against both those opinions.

Ptolomie.

Scholler.

Then must they needes be good: for as I heare all learned men say, Ptolomy is the father of that Arte, and proueth all his wordes by strong and inuincible reasons.

Maister.

Authoritie of Writers.

No man can worthily praise Ptolomy, his trauell being so great, his diligence so exact in obseruations, and conference with all nations, and all ages, and his reasonable examination of all opinions, with demonstrable confirmation of his diuine assertion, yet must you and all men take heede, that both in him & in al mens workes, you be not abused by their authoritie, but euermore attend to their reasons, and examine them well, euer regarding more what is saide, and how it is proued, then who saieth it: for authoritie oftentimes deceiueth many men, as here by and by in Cleomedes it shall appeare, whose ar-

arguments in confuting the other two opinions are nothing ſubſtantiall: which chanced, either becauſe he ſaw the fondneſſe of theſe opinions ſo great, that he ſought no greater reaſons to confute them, either elſe haſting in his writing cauſed him to vſe the leſſe diligence in framing his reaſons, and now will I repeate them. If the earth were of cubike forme, then ſhould all nations haue ſixe houres day onely, and eighteene houres night, ſeeing there be round about the cube foure ſides, ſo that on eache of them the ſunne ſhould ſhine ſixe houres onely: this is a very weake argument.

Cleomedes argument againſt the firſt opinion.

Scholler.

Yet vnto me it ſeemeth a ſtrong reaſon: for ſeeing that the ſunne doth go round about the ſkie and about the earth alſo iuſt in four and twenty houres, it muſt needes followe that he ſpends onely ſixe houres in euery quarter: and a cube hath but foure ſides in his compaſſe (although it haue ſixe ſides in all) wherefore in mine opinion it is well concluded, that euery one of thoſe foure ſides, do ſee the ſunne ſixe houres iuſtly.

Maiſter.

Often haue I read in Galen, and more often haue I ſeene it by experience, that better it is for men to want all arte of reaſoning cleane, then to haue ſuch confidence in a meane knowledge thereof, that may occaſion them to deceiue themſelues, and to ſeduce other. You are fully perſwaded that this argument is good: whereby it appeareth that you eſpied not the want of that meane propoſition, which ſhoulde make the argument good, which muſt bee this: that euery quarter of the ſkie agreeth to one quarter of the earth.

Scholler.

That not onely I thinke to be true, but your ſelfe affirmed it alſo before this time, as a true ſentence.

Maiſter.

And ſo will I do ſtill, affirming it of the true forme of the earth, but not of this imagined cube forme.

Scholler.

Is there any difference in the quarters of any formes: is not a quarter of a cube the fourth part of it, as wel as a quarter of a globe is the fourth parte of the globe?

Maiſter.

Yes, but yet doe not the quarters of the cube ſo agree with the quarters of a globe, as the quarters of two globes agree together.

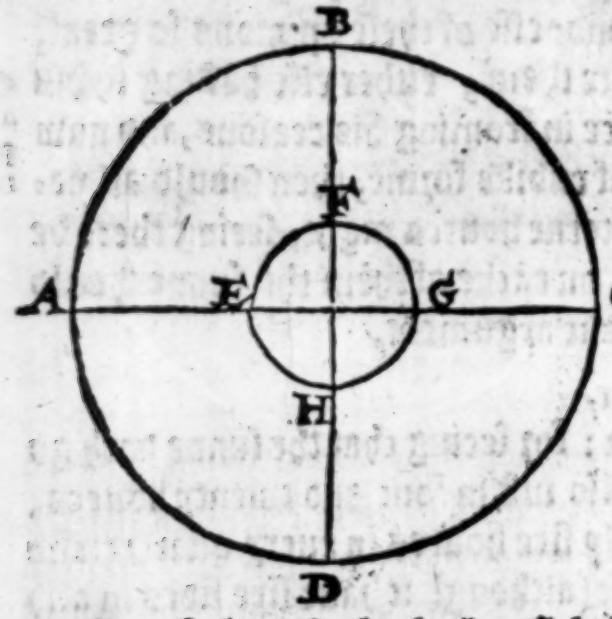
Scholler.

That I vnderſtand not.

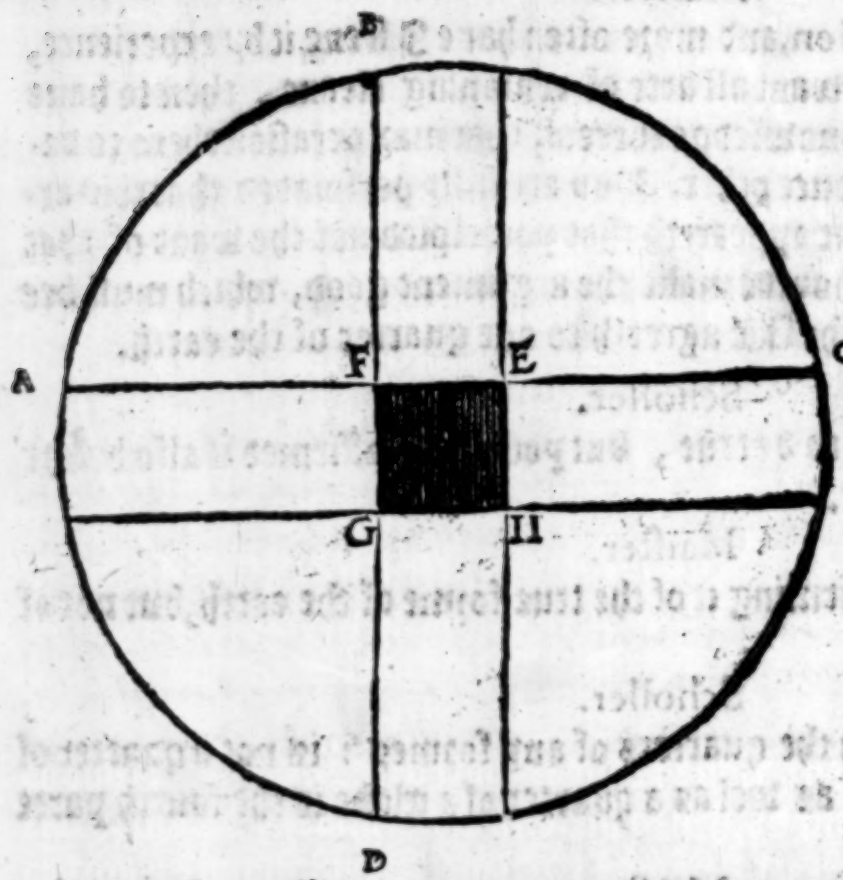
Maiſter.

Then will I declare it manifeſtly euen by linearie demonſtration.

Marke



Marke these figures. Here you see first for the true opinion two circles drawne one within the other vppon one centre, and the same are diuided into foure quarters ech of them, so that the foure quarters of the lesser circle, E F G H, do answer agreeably to the foure quarters of the greater circle A B C D. but in the second figure, where the cube is made in lieu of the earth, the quarters doe not agree, as you may perceiue by the draught of the right lines, agreeable to ech side of the cube: for euery side of the cube hath almost halfe the circle aboue his horizontall line. Wherefore to haue a cube drawen in a globe, in such sort that the quarter of the one in compasse shal agree to the like quarter of the other, that cube must bee so great, that his corners may touch the globe on ech side, so must it be as great a cube as can be made within that globe. And I am sure you will not say that the earth is so great in comparison to the skie.



Scholler.

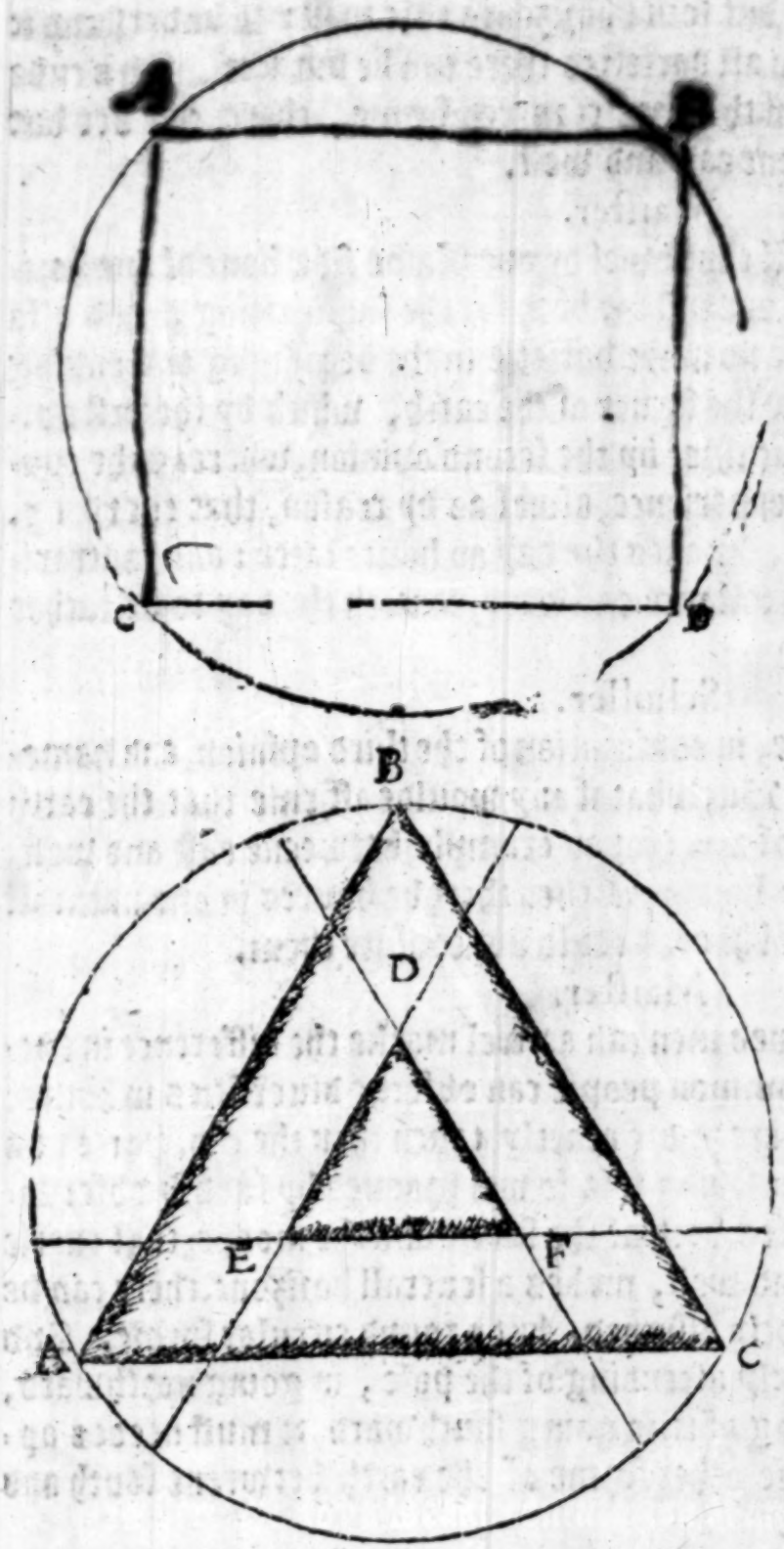
Now I see mine owne errour, and the fault of Cleomedes argument.

Maister.

And if any man would excuse Cleomedes, hee must say, that Cleomedes did make that reason against such as affirmed two errours at once, that is, the cubike forme of the earth, and the greatnes of it also to be such, as might touch the skie with euery corner: but if this had bin his meaning, hee might easily haue expressed it so: but whatsoeuer he meant, he framed the confutation of the second opinion in the like sort: for this is his argument.

Cleomedes confutation of the second opinion.

If the earth be of a three cornered forme, then should the sunne shew eight houres iustly on ech side of it, and so would it be to all people eight houres day,



day, and fifteene houres night: which thing is too apparant falſe: ſo can not that opinion be true: for declaration of this argument I haue drawen firſt a circle for the ſkie, and then a ſmall triangle forme D E F, vnto whoſe three ſides I haue drawen three ſtreight lines, repreſenting three ſeuerall horizonts: but it appeareth at the firſt ſight, that each of thoſe horizonts doe containe aboue them almoſt halfe the ſkie: ſo that in this quantitie of the earth Cleomedes reaſon taketh no place, neyther generally in any other but one, where the three corners of the earth may touch the ſkie, for which forme I haue drawen the great triangle A B C.

Scholler.

Yet although Cleomedes argvments be not ſufficient to confute their opinion that would ſay the earth were of anye of both theſe formes, their opinion is falſe neuertheleſſe: thinke you not ſo?

Maiſter.

Yes verely: for a weake confutation of an vntrueth doeth not make that vntrueth to become true. And bicauſe you ſhall not thinke that theſe opinions haue any ſure ground, I will repeate Ptolomie his confutation of them both, by one infallible reaſon. You ſee in both theſe imagined formes of the earth, that there can be no more horizonts, then there be ſides in the figure.

Ptolomy his confutation of the firſt and ſecond opinions.

Scholler.

That is certaine: for all that dwell on one plaine ſide, muſt needes haue

one horizont: wherefore if the forme of the earth were foure square in his compasse, then could there be but foure horizonts that way: I understand it betweene east and west, and in all varieties there can be but fiue, for a cube hath but fiue sides: likewise in the three cornered forme, there can bee but three diuers horizonts betweene east and west.

Maister.

Well saide: And seeing all that dwel on one plaine side haue al one horizont, they must haue day al at one instant both for the sunne rising, and also for the setting, so can there be no more varietie in the beginning and ending of dayes then there are sides in the figure of the earth, which by the first opinion must be but foure, and but three by the second opinion, whereas the contrary is wel knowen by daily experience, aswel as by reason, that euery 15. degrees in distance westward, makes the day an houre later: and contrariwise euery fifteene degrees of distance eastward, causeth the day to be rather by one houres space.

Scholler.

That is prooued also before, in confutation of the third opinion, and namely by examples of eclipses. But what if any woulde affirme that the earth were made of many flats, as of 24. (for an example) betweene east and west, then shoulde there be no more horizonts then there be houres in one naturall day, and yet so the difference of houres could not confute them.

Maister.

You must thinke that learned men can as wel marke the difference in euery minute of an houre, as ỳ common people can obserue diuersities in hours: yea the learned obseruations are more exactly taken then the 60. parte of a minute of an houre, wherefore seeing it is so wel prooued by sundry obseruations, and especially by eclipses, both of the sunne and the moone, that euerie mile distance betweene east and west, makes a seuerall horizont, there can be no other forme of the earth aptly assigned, but a round cirrular forme. And by the like reason, by the orderly ascending of the pole, in going northward, and by the uniforme descending of it, in going southward, it must needes appeare that there can bee none other forme of the earth betweene south and north, but a round forme also.

Scholler.

Now can I end your argument of the distribution disiunctiue, which may be framed thus.

The collection of the arguments by distribution disiunctiue.

The earth must haue some forme, either cubike, three cornered, flat, or hollow, or some such like, or else a round forme, but his forme cannot be cubike, nor three cornered, neither flat, neither hollow, nor any such like, as before is fully prooued, wherefore it must needes be round.

Maister.

It followeth well: for it is not poſſible that in any other imagined forme of the earth, the horizonts ſhould alter toward euery coaſt ſo vniformely, and the dayes differ ſo proportionably, the pole to be eleuate ſo ratably, or to bee depreſſed ſo orderly, and al other apparances to anſwer ſo agreeably. Some (as Ptolomy reporteth) had inuented an other forme like a roller, or a round piller, whoſe endes ſhould lie north and ſouth: by which forme though they thought none of the varieties of appearances might be hindered, yet in that forme the eleuation of any one of the poles could haue but two varieties, for euermore it muſt appeare either ouer their heades, as to them that dwel on the flat endes of that roller, or elſe to al other that dwel about the compaſſe of the roller, it muſt ſtil appeare in their horizont, ſo ſhould there bee no ſtarres about either pole alwaies apparant aboue ground, neither alwayes hid vnder ground, but al ſtarres ſhould riſe and ſet to al them that dwel about the roller. And againe, they that dwel on the flat endes of the roller, ſhoulde haue but one horizont, ſo large in diſtance of ground, as the whole thickeneſſe of the earth is: al which imaginations are both wel knowen to be vaine, and alſo eaſie to be confuted by the former reaſons, which ſerue ſo largely, that you can imagine no forme other then round, but thoſe reaſons will confute it: wherefore your argument proceeds wel.

A roller forme.

And further, for the roundneſſe of the water alſo, and namely of the ſea, you may frame arguments by the like forme of appearances: for whereſoeuer you be on the ſea, you ſhal ſee halfe the ſkie iuſtly, and the farther weſt you doe goe, the later doth the ſunne riſe: and contrariwiſe the farther eaſt you ſaile, the ſooner in the morning wil the ſunne appeare to you: whereof I wil declare vnto you a notable example, and a iuſt proofe.

That the water is round by diuers proofes.

Imagine a ſhip ſwift of ſaile to be at the cape of Cornewal ready to make ſaile toward the weſt directly, and to haue a great gale of winde, it is poſſible that ſhee may runne two hundred and forty miles in foure and twentie houres: for I haue bin at the triall of a greater courſe, therefore I ſpeake (as men ſay) within my bounds: after which rate ſhee ſhall runne in ſixteene houres one hundred and ſixtie miles. Now let her hoiſe ſaile at the ſunne riſing, and let the time of the yeare be ſomewhat before midſummer, or little after, when the artificial day from ſunne riſing to ſunne ſetting, is ſixteene houres long: by this meanes at the end of ſixteene houres, ſhe ſhal be weſt of the cape of Cornewal where ſhe beganne her courſe one hundred and ſixtie miles: and then ſhal the ſunne be at ſetting to their ſight that dwel at the ſaid cape, but the ſhip ſhal haue the ſunne aboue 4 degrees high at that inſtant, by reaſon that ſhe did runne with the ſunne, and that the roundneſſe of the ſea changeth the horizont ſo many degrees in 160. miles.

An example of the roundneſſe of the ſea by a ſhips courſe.

Scholler.

Although this example be pleaſant, yet it paſſeth mine vnderſtanding,

fith that I beleeued hitherto, according to your former doctrine, that 160. miles would not haue altered any wayes three degrees, seeing 60. miles answer to one degree.

Maister.

That saying is true alwayes for the elevation of the pole, for going betweene south and north in all places, but for going betweene east and west, it serueth onely for the middle of the worlde, that is, vnder the equinoctiall circle: and in al other places, the further you be from the equinoctiall, the fewer miles answer to eth degree, by reason the paralels grow lesser stil toward the poles: yet the least of them is diuided into three hundred and sixty degrees as wel as the greatest, whereof hereafter I wil instruct you more exactly: in the meane season, you shall vnderstand, that for the latitude of the Cape of Cornewall, euery degree requireth onely seuen and thirty miles: which being multiplied by 4, maketh but one hundred fortie and eight: and therefore I said aboue, foure degrees did answer to one hundred and sixtie miles, as the truth is.

How many miles answer to a degree at the south coast of England.

Scholler.

Now I perceiue somewhat better the reason thereof by the proportion of the paralel circles in the sphere: and surely this proofe is pleasant, and easie enough to be tried.

Maister.

A like example may this be: Suppose at the same time of the yeare when the day is at the longest, that there is a swift ship at the west point of the Isle of Island, where the longest day is twenty houres from sunne rising to sunne setting, in those twenty houres that ship might saile westward two hundred miles. Then considering that at that latitude which is aboue 63. degrees, there answereth but 27. miles to a degree: when the ship is at the end of his course, the sunne wil set to them that be in Island, and then shall the shippe haue the sunne seuen degrees and almost a halfe aboue the horizont, (which makes halfe an houre in time) so that by the roundnesse of the sea, they haue changed their horizont so much in twenty houres sayling. Nowe turne his course, and let the ship haue like winde homeward againe the next day, and let him make saile at the sunne rising, then shall it be after sunne set halfe an houre before she shal arriue at the former poynte, by reason that the sunne rose halfe an houre later to the ship, where she was in the west, then it did to them at Island, and therefore must it set halfe an houre rather at Island: so hath the ship lost halfe an houre, by comming eastward against the sunne.

A like example of a ships course.

Scholler.

I vnderstand that. As fifteene degrees doe answere to an houre, so 7. degrees and a halfe make halfe an houre: wherefore if the ship saile iust twenty houres,

houres, and that artificiall day is iuſt 20. houres long, then ſhal they come to their port in Iſland halfe an houre after ſunne ſetting, becauſe it was halfe an houre after ſunne riſing in Iſland, before they began to make ſaile.

Maiſter.

This varietie could not happen, except the water alſo were round as well as the earth. And for farther proofe of the roundneſſe of the ſea, dayly experience doth teache vs, if we would diligently obſerue it, howe that when a ſhip doth drawe toward land out of the maine ſea, the lowe grounde doth not appeare at the firſt vnto the ſhip, but the tops of high hilles and cliffes: likewiſe they that be on the land and looke to the ſhip, they ſee the top of the ſhip firſt, and after that, the maſtes, ſailes, and ſhroudes before they can ſee the hulle, and body of the ſhip. Nowe I demaund of them that thinke the water to be flat, what is it that letteth the ſight, ſo that it cannot as well ſee the lower ground from the ſhip, or the hull of the ſhip from the land.

Another proof that the water is round.

Scholler.

They can name nothing but water: for there is nothing els between them, able to ſtay the ſight. But then peraduenture they will ſay, it is the waues of the ſea which riſe very high oftentimes.

Maſter.

That were too childiſh an anſwer, ſith the like doth appeare, and that moſt exactly, in a great calme, when the Sea ſeemeth as plaine and as ſmooth as a bord: ſo that they muſt ſhew ſome ſuch thing as is higher bet ween them then ante of both their ſighres, when the ſea is as quiet as can be.

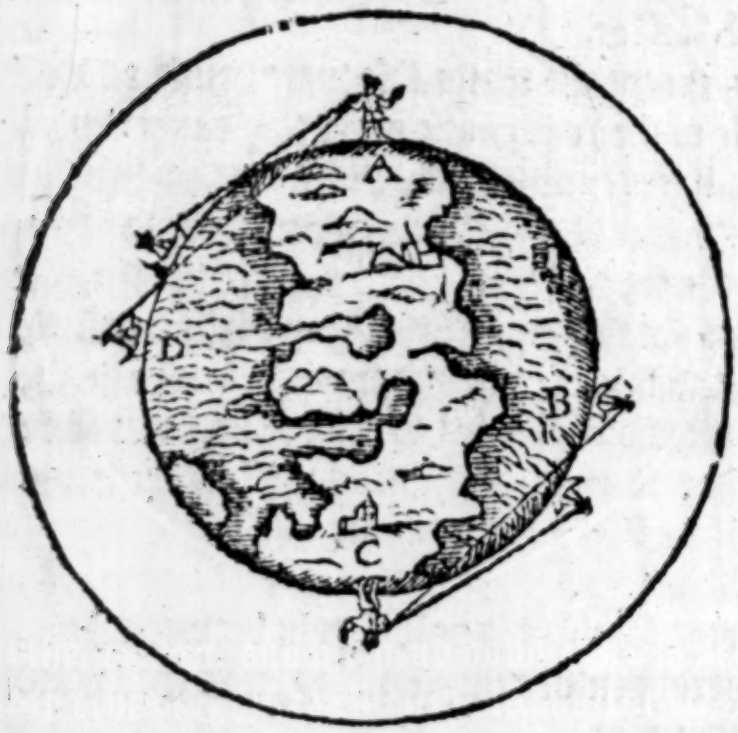
Scholler.

Then is there nothing but water. But then it ſeemeth to mee, that if the water did riſe round, the farther the ſhip were from the land the higher ſhee ſhould be, and therfore the better might be ſeene.

Maiſter.

Your imagination hath ſmall ground of reaſon: for although the earth and the water both ioyntly and ſeuerally be round of nature, and therefore haue in deed no place higher then other in their circumference, yet all vulgar men ſhall thinke by appearance that that place is higheſt where they ſtand, and that from them on eche ſide there is a round deſcent, vntill by imagination they come to the right contrary point where their Antipodes be, whom they ſhall thinke to be right vnder them, where as theſe Antipodes haue the contrary imagination, that they dwell on the higheſt part of the ground, and that their Sea is higheſt, and ſo both deſcendeth compaſſedly vnto the contrary point to them againe. And thus euery other ſort of people thinke that they dwell on the higheſt part of the land, and alſo of the Sea, (if they dwel on the Sea) and they ſhall thinke that both the ſea as well as the land doth

descend from them eche waies. As in this circular forme of the earth and sea, the men that dwell by A, thinke themselues to dwell highest of al other, so that on eche side of them the land and sea seemeth to descend: and therfore they iudge the ship that is by B, to be lower then they, whereas that ship, contrariwise, seemeth to them that bee in it, to be on the highest part of the world: and therefore they thinke ỳ the land by A, is lower then they are. Againe, they that dwell by C, and the ship that is by D, are of like imaginations, ech in his fantasie thinking him selfe highest, & the other lower. And so of them that dwell by A & by C, ech marueileth how the other can go, and his head downward: yet indeed none is lower then other. For eche of them is equally distant from the centre of the earth, which is the lowest place of all other. And therefore no way is accompted lower except it be neerer to that centre: Whereby also it may appeare, contrary to your saying, that although the sea be round, yet shall not the ship seeme to ascend still, but rather seeme to descend, though indeed it doth none of both, but moueth circularly about the centre of the world, so that it cannot aptly be called a right motion, but a compassed motion that a shippe maketh, saue that it is tollerably to be borne in vulgar speech, because euerie small arche of a great circle, seemeth to be a right line to the sight of the eie. And in this figure is somewhat represented the declaration howe the compassed forme of the water doth let ỳ sight to see the ship: and likwise how that they on the land may see the top of the ship when they cannot see the hull, and they in the hull of the ship cannot see those places on the land, which other in the top of the ship may see, by reason that their sight is aboue the height of the water. And this may stand for a conuenient proofe.



Scholler.

So doth it appeare manifestly, now that my former misconceiued fantasie is reproued. And so I remember when I haue looked after a ship that departed from the port where I stood: first I lost the sight of the hull as though it had sunke into the sea, and yet I saw the top still: but at length I lost the sight of it also, as though all had sunke into the water. Which by your declaration

ration I perceiue doth follow of the roundnesse of the water: for other reason I can finde none.

Maister.

Although you could find other reasõs neuer so many: yet this reason doth enforce that effect. This is the reason that Ptolomy, Cleomedes, and after them *Ioannes de Sacro Bosco*, and other also doe alledge, but the same Iohn hath another reason more physicall then Geometrical, borrowed out of naturall philosophy, which is this: Seeing that the water is a body of vniforme substance, the partes of it must be of like condition as the whole body is: but the parts of water doth alwaies couet a round forme, as wee see in euerie drop that falleth from any thing, or standeth on any thing) wherefore of iust congruence the whole body of the sea and water must needes couet the same forme. A physicall reason for the roundnesse of the water.

Scholler.

Indeed al drops that fall from the aire in a milde raine, when men may marke it, doe fall in a round forme, and so the drops that fall from the eaues of the house, or from any thing els, yea and the drops of dew that stand vpon any leaues of herbes, or other like thing.

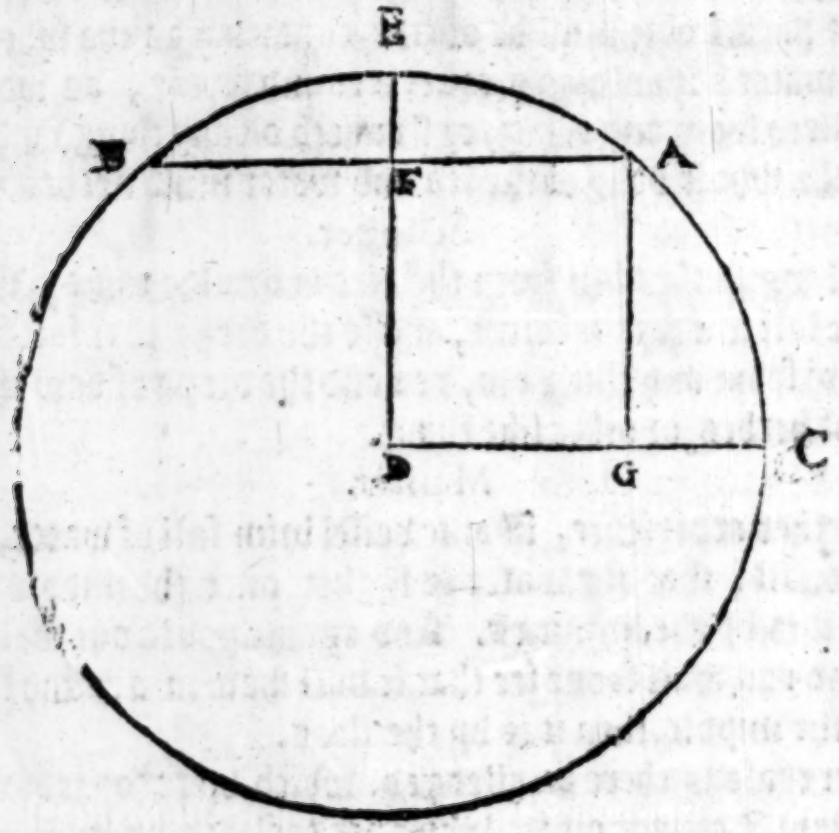
Maister.

For a farther experience, fil anie vessel vpim full of water, and you shall perceiue by triall, that the water is higher ouer the middle of that vessels mouth, then it is by the brimmes. And againe poure out water on a bord or on a stone, and you shall soone see that it will shew in a round forme, and wil be deeper in the middle, then it is by the sides.

Yet farther reasons there be alledged, which were too tedious to repeate: but two of them I cannot omit, which are declared by Erasmus Rheinholt a man not only of great learning, but also of as great honestie in seeking to profite al men by his trauel, although sometime he wanted leisure to examine some of his writinges, as it may appeare by one of those two reasons, which is this. Erasmus Reinholt.

By the long course of euery great riuer (saith he) it may appeare that the water doth couet a round forme, els could it not so much rise in roundnesse, as it doth in running so long a course: for example hee bringeth the course of the great riuer Danubius, which springeth in the West mountaines aboue Ulma in Sueuia, and entereth into the Sea Euxine, aboue Constantinople, which is from Ulma 312. Germaine miles, that is 20. degrees, which is the 18. part of the whole circuit of ỹ earth: wherby it must needes follow that the middle of that riuer is higher then the fountains or the mouth, by 13. germaine miles (ỹ is 52. English miles) in plumbe height: for the declaration wherof he maketh this demonstratiõ lineary, supposing A E B C, to be as one of the greatest circles about ỹ earth, whose cẽtre is D. this circle must be imagined so to passe agreeably to ỹ course of Danubius, ỹ A may represent the Another reason.

fountaines of it, B the mouth of it, so E shal stand for the middle part of the riuers course, and A E B, for the whole course. Now is it said before, that betweene A and B, are 20. degrees: then if you draw a right line from the one to the other, as here you see A E B, it will be lower vnder the middle of the arche, by the length of the line E F, which is almost the 60. part of the semidiameter of the earth, and maketh iustly 52. English miles, somewhat lesse then 57: which is the 60. part of the semidiameter of the earth.



Scholler

This reason seemeth pleasant, but I perceiue not the reason of the iust quantitie of the line E F.

Maister.

That dependeth of the arte of Signes and Cordes, and is very certaine without any sensible errour, of which in another place ye must learne the vse. And indeed as you say, this reason is pleasant, and the authour much to be praised and loued, and as much is it to be lamented, that the shortnesse of his life would not permit him to haue recognised his workes againe: wherefore that he cannot doe by preuention of death, I trust some of his friendes will doe: for although they bee but little faultes, yet pitie it is that in so good workes there should remaine any little spottes, as in this argument there are two, which yet hinder not the argument. And although it might be truely said that the height of the middle of Danubius is not 52. mile, and is but 36. mile; yet is the forme of his argument good, for that height is sufficient to proue, that the middle appeareth much higher then the fountaines of it:

the

the cauſe of this ouerſight was, that he did eſteeme the courſe of Danubius, to runne by one of the greateſt circles of the earth, which is not ſo: for it hath in latitude from the equinoctiall 46 degrees, ſo muſt the paralelle of his courſe be little more then two third partes of the greateſt circle: but as this is ſomewhat too ſtrange for you, yet being vnexpert in the arte of Coordes and Signes, and in the knowledge of Coſmographie, ſo I will let it paſſe with this light admoniſhment, wiſhing that hee had alſo more aptly expreſſed his meaning, and the vſe of his termes, for auoiding of ſlaunderous tongues: for it might now be anſwered him, ỳ Danubius is no higher in one place then in another: ſeeing al diſtance of height is to be accompted from the centre: and the middle of the riuer by E, is no farther from the centre D, then is the fountaine A, or the mouth B.

Maiſter.

Mary that obiection is certaine, and therefore is his errour manifeſt, and his argument of no force.

Scholler.

You triumph too much before the victorie. His argument is better then you doe conſider it: his intent was to proone that the water doth not run by a right line and downward ſtill, as the vulgar ſort doth imagine, but that it runneth circularly: wherefore it followeth wel againſt the vulgar opinion, to ſay that the water of Danubius is higher in the middle of this his courſe, by ſo many miles in height plumbe vpright, then it ſhoulde be by their imagination. So is there none other fault in this point, but the want of diſtinction of the true opinion of highneſſe and lowneſſe, from the wrong taking of the ſame names, whereby thoſe which doe not know his great learning, and might happen to heare his argument, would iudge that either he were wonderfully deceiued, either els that he did too much abuſe his termes: but if death had not preuented him, he would haue declared his meaning, I doubt not, as I haue delared it. Erasmus Reinholt excuſed.

Now to his ſecond argument: he proueth that there can be no ſuch holowneſſe in the ſea, as there is betweene two hilles: for ſeeing the Sea is a heauie body, and preſſeth toward the centre of the worlde, euerie part of it will doe the like if it be not ſtaied. And the water being a liquid and fluxible body, cannot be ſtaied by his owne partes: wherfore it foloweth, that there can remaine no valies nor dales, nor hollow partes in it, but it ſhal quickly be filled with water. And therefore we ſee, that nothing can be more plaine then is the top of water, ſith euery part ſo exactly ioyneth with other, in filling vp al vnequalitie: whereof it followeth, that if the top of the water be iuſt equall and like diſtant from the loweſt part of the worlde; (which hath been often declared to be the centre of the earth) then muſt the face of the water needs be round, according to the definition of a circle. Erasmus Reinholt his ſecond argument.

Scholler.

Why the water doth not couer all the earth.

That followeth well indeed: for as eche part of the circúference in a circle is equally distant frō the centre, so if al parts of ẏ face of ẏ water be equally distant from the centre, it must needes be circular, as the circumference of a circle is. But if it be so round, and ought to haue his place aboue the earth, how doth it happen that it doth not couer the whole face of the earth? and so should there be no earth seene.

Maister.

Haue you forgotten what you read in *Ioannes de Sacro Bosco*, for to answere that question?

Scholler.

Indeede hee saith that the other three elementes doe compasse the earth round about, saue that for the preseruation of man and beastes, the drinesse of the earth doth withstand the moisture of the water.

Maister.

That reason sauoureth more of the determinations theologicall, then of the demonstrations mathematicall: Wherefore I will adde thereto a proofe by good demonstration that it cannot compasse the earth round: for which purpose first I say, that the water being inclosed within the bounds of the earth, cannot be so great as the earth is. Againe considering that one portion of water being mixed with 4. times so much earth, would make it all soft and flabbie: it may not be thought that the water of the Sea and of all riuers and springes ioyned together, is so much as the first part of the earth. Furthermore, if you consider the firme stablenesse of the earth, and the vnstable swarming of the water, you would thinke that if the water were able to match the twentith part of the earth, it would make the earth more vnstable, then the nature of the earth, and the preseruation of earthly creatures could beare. Yea, it would be a weake ground to beare so wonderful a waight as it doth, if the quantitie of water were notable in comparison to the quantitie of the earth. Yet now for farther triall, suppose (as I thinke it true) that on the flat face and circumference of the earth, there is as much water as land, so might it appeare that the water were as much as the land, as many men doe affirme.

That the water cannot compasse the earth.

1
2
3
4
5

Scholler.

And most part of learned men (as I haue heard say) doe vouche that as most certaine trueth.

Maister.

It is true, as I iudge also, if they mean like cosmographers, that half the face of the earth (as I said) is couered with water, but then imagine what depth may that sea be of.

Scholler.

No man can tell.

Maister.

Yet

Yet by triall of mariners, it hath been found in few places a hundreth fadomes deep, which is little more then the tenth part of a mile.

Scholler.

That notwithſtanding, it may be deeper in ſome places.

Maiſter.

For a ſuppoſition, imagine it were in all places a mile deepe, taking one place with another.

Scholler.

I thinke that too too much a great deale, conſidering that all known parts are not in the deepeſt, accompting one place with another, as good mariners can teſtifie, aboue 40. fadome, and ſo groweth ſhallower ſtill to the ſhore.

Maiſter.

The more that that ſuppoſition exceedeth trueth, the ſtronger ſhall the proofe be of the ſmalneſſe of the water in comparison to the earth.

Scholler.

Then for trials ſake, I ſuppoſe it were ſo.

Maiſter.

How deepe thinke you now the earth to be?

Scholler.

I remember you ſaid before, that 57. mile was but the 60 part of the ſemidiameter of the earth: then muſt the whole earth be in thickneſſe 6840. miles.

Maiſter.

That is agreeable to that rate: but as I ſaide before, the diameter is 6872 $\frac{8}{11}$. And now if you abate one fift part of that depth, the reſt will make the ſide of a cubike forme, almoſt as great as the globe of the earth: as it appeareth in the workes of Geometry.

Scholler.

The fift part of 6872 is 1374. Which being deducted from 6872, there reſteth 5498.

Maiſter.

That number is ſomewhat too little, but 5541 is very nigh the ſide of a cube, equall to the globe of the whole earth, therefore multiply it cubikely, as you haue learned in Arithmeticke, and then ſhall you ſee, how may miles ſquare are in the whole globe of the earth.

Scholler.

If 5541 be multiplied by it ſelfe, it maketh in ſquare number 30702681, which beeing multiplied againe by 5541, doth yeelde 170123555421: which is the cubike number to 5541. And ſo conſequently muſt it be

5541
5541
5541
22164
27705
27705
30702681

that cube which is equall to the earth, in his whole globe.

30702681
5541
30702681
122810724
153513405
153513405
170123555421

Maiſter.

So is it very nigh. But now for the quantitie of all the ſea, this way muſt you worke. Firſt to know all the platface of the earth, you muſt multiply his circumference by his diameter, as it is declared in the Pathway, and ſo wil there amount 148450909: which is the full platforme of all the face of the earth: whereof preſuppoſing (as the trueth doth inforce vs) that halfe the ſame is Sea and Water: then doth it follow, that the whole plat face of the ſea and water is 74225454. miles and a half in all togither, which is not the 2000. part of the earth.

21600
$6872\frac{8}{11}$
15709
43200
1512
1728
1206
148450909

Scholler.

But muſt not this number be multiplied by the depth of the Sea.

Maiſter.

Seeing that depth is not in one place with another aboue one mile, and I doth neither multiply nor diuide, it will remaine as it is.

Scholler.

Then dare I thinke farther, that the depth of the Sea being not a quarter ſo much generally, the earth muſt needes be 10000 times ſo great as the Sea, and all other waters.

Maiſter.

Your wordes erre not much from the trueth: and therefore by this reaſon it doth appeare, that the water being ſo little in compariſon to the earth, cannot aptly compaſſe the earth. And by this it appeareth alſo how childiſhly they doe erre, that thinke the water to be ten times ſo great as the earth: for if it were but twiſe ſo great as the earth, it muſt of neceſſitie couer all the face of the earth: yea I will ſay conſtantly, if al the water were as much as the hundreth part of the earth, it woulde ouerrune al the earth, and couer it cleane: which I may eaſily prooue, but not briefly: and ſeeing the ſame is alreadie declared in the Pathway, I will omit it heere, ſith it is a more appropried proofe for Geometrie, then for Aſtronomie: and nowe will I returne to the proſecuting of our former matters, accompting this

ſufficient

ſufficient for the declaration of the roundneſſe of the earth, and alſo of the water ſeuerally: and now wil I adde one reaſon to approoue that both they make one perfect round globe.

Euery groſe and ſound body giueth a ſhadow like vnto his owne forme: the earth is a groſe and ſound body, therefore muſt it giue a ſhadow like his owne forme: but in al eclipſes of the moone, which are cauſed by the ſhadow of the earth, his ſhadow is alwayes conſtantly round, whether the ſhadowe doe runne eaſt, weſt, ſouth, or any otherwaies mixtly: wherefore it foloweth, that the forme of the earth is round, which giueth that round ſhadow.

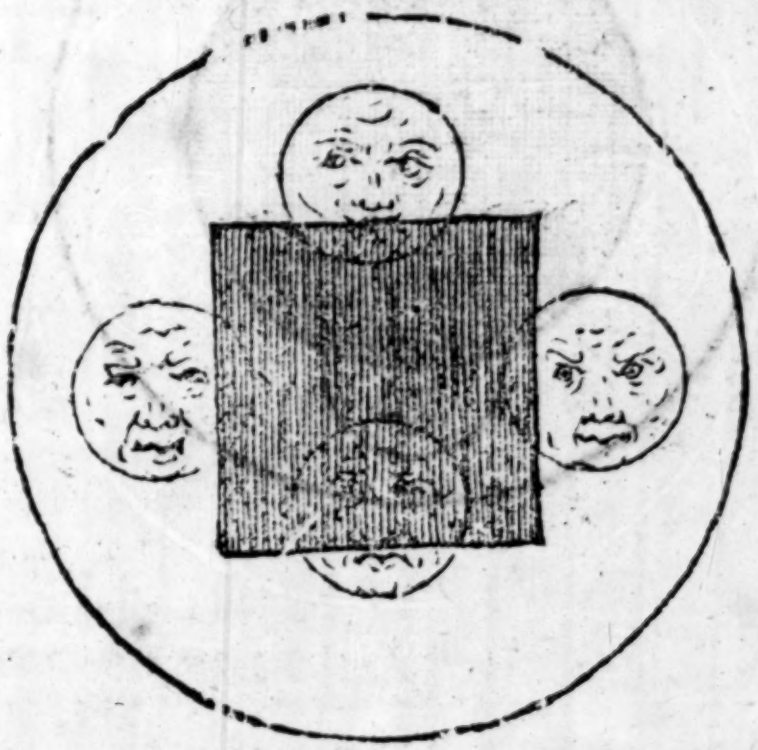
Scholler.

How ſhal a man vnderſtand that the ſhadow of the earth is round?

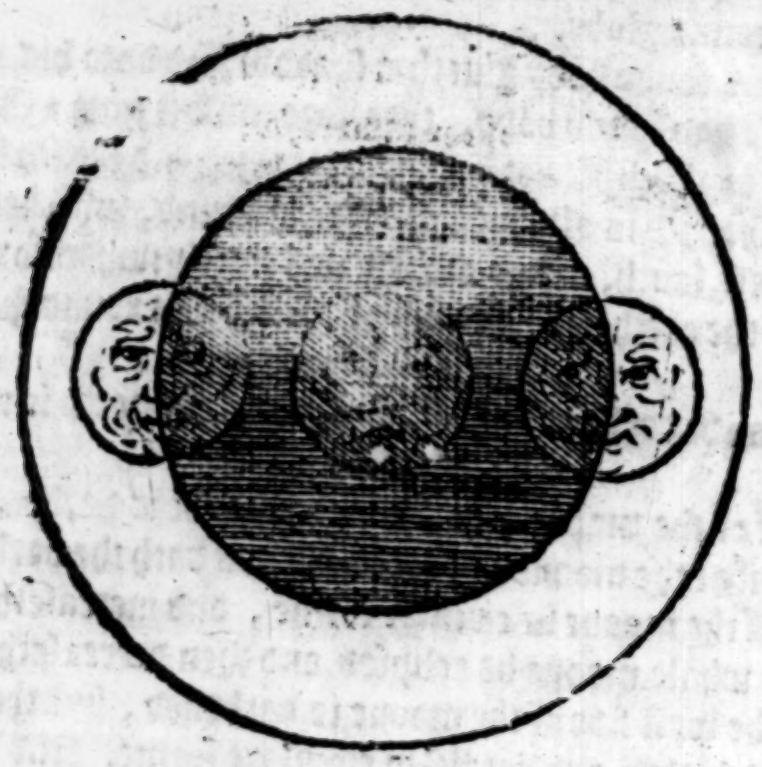
Maiſter.

In the eclipſe of the moone, either al the moone is darkened, or elſe but one part of her: if al the moone be darkened, then doth the darkeneſſe beginne on the eaſt ſide of the moone in circular forme, and increaſeth ſtil in the ſame forme, til al the whole moone be eclipſed, and then decreaſeth the darkeneſſe againe, ſo that the weſt ſide of the moone is darkened, but the darkeneſſe fadeth by little and little, and yet ſtil in circulare forme. And if the moone be darkened onely in one part, whether it be the ſouth part, or the north part, yet ſtill is the ſhadow round in forme: whereas if the earth were ſquare or cubike, either three cornered, or of other ſuch forme, the ſhadow woulde ſo appeare in the moone, as by the third and fourth figure, you may partly perceiue.

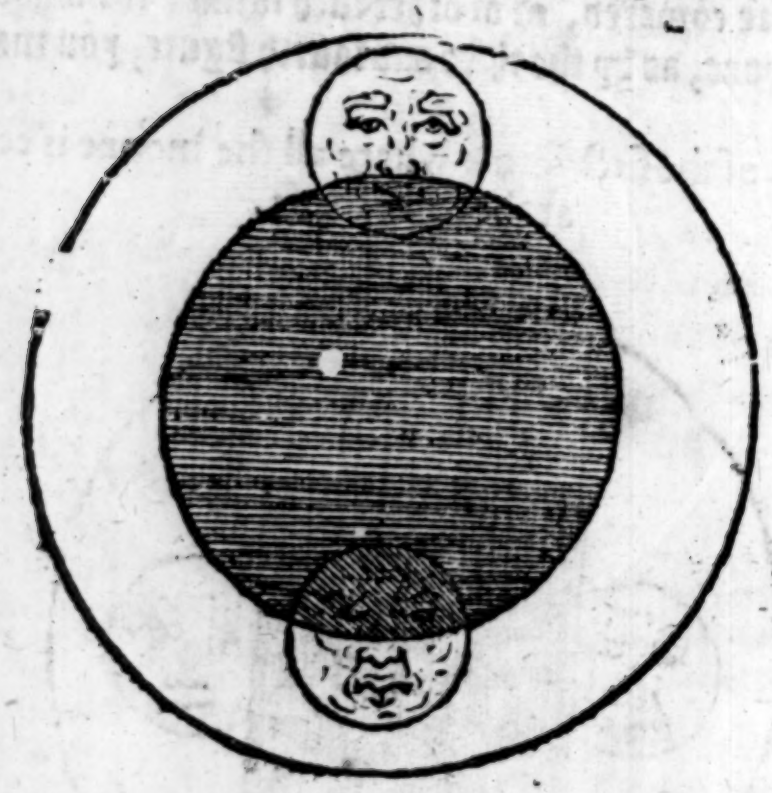
Examples of the firſt forme where all the moone is eclipſed at the full eclipſe.



Example of the third and fourth formes.



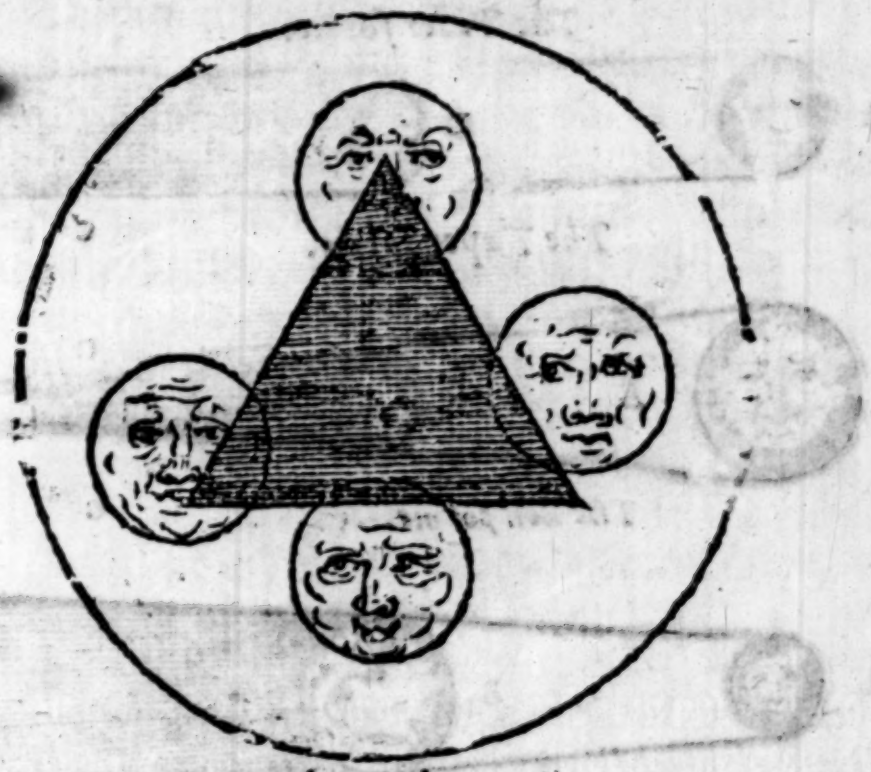
Examples of the third and fourth formes.



Examples

Examples of the other two ſortes, of one part eclipſed.

The ſouth part.



The north part.

But I wil omit this matter til anone, becauſe it is not eaſie to vnderſtand without further explication of other matters incident thereto. And becauſe I haue begunne to ſpeake of the ſhadow of the earth: I wil alleadge one argument more, taken by the ſame ſhaddowe to approoue the ſmalneſſe of the earth in compariſon to the ſkie: wherefore thus I frame mine argument.

That the earth is but a pricke in reſpect of the ſkie.

The ſunne is but a very ſmall portion in compariſon to the whole ſkie, and yet the ſunne is manifolde bigger then the earth: wherefore the earth muſt needes be but a very ſmall thing in compariſon to the heauens.

Scholler. Your argument is good, and the *maior* is manifeſt to euery mans ſight: but how do you prooue the *minor*?

Maiſter.

Euery darke body giueth ſhadow according to the quantitie that it beareth to that ſhining body which giueth the light, ſo that if the ſhining body be equall to the darke body, then doth the ſhadow runne in forme of a piller, or of a roller, like bigge at both endes: but if the bright body be greater then the darke body, then doth the ſhadow grow leſſer and leſſer in ſpire forme, or taper faſhion, and at length doth end in a ſharpe point. Contrariwiſe, if the light body be leſſer then the darke body is, then doth the ſhadow grow greater and greater ſtil as it goeth from the darke body, and is ſmalleſt at the beginning, contrary to the taper forme, which is greateſt at the beginning: and this forme may be called maund-forme, or bell-forme, becauſe it is like a maund baſket, or a bell.

Scholler.

Examples of theſe three diuers ſhadowes.

The Piller forme.

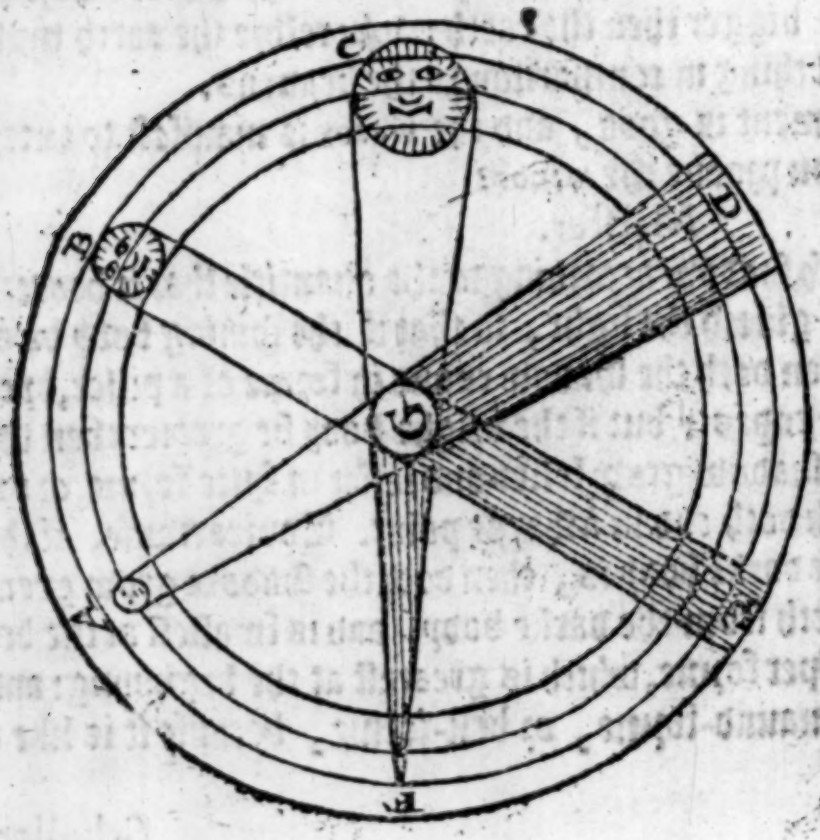
The Taper forme.

The Bell forme.

A repreſenteth the ſunne or other light body, B the earth, or any darke body, and C the ſhadow.

Scholler.

This may ſtand as a ſure maxime, ſith both reaſon and ſenſe do teſtifie it to be true.



Maiſter.

Then do I infer further, that if the ſunne were leſſe then the earth, the ſhadow of the earth would growe greater and greater, and would be infinit in length whereby it would darken the moſt part of the ſtars euery night: and very often it woulde ſhadowe the moone, and that for a long ſpace together, as you may gather by this figure, where A repreſenteth the ſun in leſſer forme then the earth, which is ſignified

signified by the circle marked with G, and the shadow that commeth by this forme, is marked with D, which occupieth a great parte of the skie, and therefore woulde darken all the starres in so much space of the skie, which is nigh hand a quarter of that hemisphere that is aboue our horizont. And as the shadow turneth about according to the motion of the sunne, so in foure and twentie houres al the starres that be nigh vnto the zodiake, should suffer eclipse: which thing is contrary to daily experience, for we see there (about the zodiake and against the sunne) the starres very bright.

Scholler.

This reason doth suppose, that the starres do receiue their light of the sun, which thing was not yet proued by you, although I thinke it to be true, yet in a good argument, no doubtful sentence may be alleadged.

Maister.

Then seeing this place doth not conueniently permit so long a digression to proue that, I will vse the moone for an example, which appeareth so manifestly to borrow her light of the sunne, that according as shee receiueth the light from him, so doth she appeare greater or lesser in light, according to her distance from him: and whensoeuer she commeth into the shadow of the earth she leeseth hir light, either fully, or in part, accordingly as she passeth and toucheth the shadow of the earth: wherfore as long as the moone should be within that shadow, she must needes be in the eclipse: and the shadow being so great, shee should be eclipsed, not onely euery moneth at the full, but shee should continue almost foure dayes togither in the eclipse, seeing that shadow doth occupy as much of the skie, as she doth moue by her proper course in foure dayes.

Scholler.

That absurditie is too manifest to graunt vnto: and yet the greatnesse of the shadow inferreth no lesse, sith it occupieth so much of the skie.

Maister.

The like inconuenience wil follow, if the sunne and the earth were both of one greatnesse, as are B and G in the former figure, for so would the shadow run of one bignesse like a roller, as is represented by E and would darken diuers starres, & namely al that be in the middle of the zodiake, and the moone should both oftner be eclipsed (then indeede she is) by the greatnesse of the shadow, and would tarry longer in the eclipse, by that same reason, then good reason would allow. But seeing wee perceiue no starres directly against the sunne to be eclipsed, neither yet the moone, in such forme as that piller-like shadow would cause, we must needes thinke that the shadow is much abated, before it come to the sphere of the moone, and is cleane consumed before it come at any of the starres, which kinde of abatement could not be, but where the light is much greater then is the body that maketh the shaddowe, as is C

in comparison to G.

Scholler.

So must it follow, that seeing the sunne is the light body, and the earth giueth the shadow, of necessitie the sunne must be greater then the earth.

Maister.

Yea indeede, and that manifold.

Scholler.

Then of more force must the earth be a very small body in respect to the whole skie, which is infinitely greater then the sunne, as euery childe may perceiue.

Maister.

The second reason for the quantity of the earth, &c.

And yet haue I further matter of proofe that the earth is not onely a verie small body in regard to the skie, but is without any view of greatnes in that comparison. If the earth had any notable quantitie in respect of the skie, then must the diameter of the earth haue as great a quantitie, in comparison to the diameter of the skie: for as in two circles the proportion of the diameter is equal to the proportion of the circumferences, so is the proportion of the shorter to the longer, greater then is the proportion of their two plat formes: but in two globes the proportion of the shorter diameter to the longer, is much greater then is the rate of their plat formes: and yet much more greater then the proportion of the lesser globe to the bigger.

Scholler.

That is sufficiently prooued in Geometry, wherefore you may proceede with your conclusion.

Maister.

If the diameter of the earth haue notable quantitie in comparison to the diameter of the skie, then the starres which are ouer our heades, be nigher vnto vs by a notable quantitie, then when they be in the east, or in the west.

Scholler.

Indeede they are neerer by the semediameter of the earth: which of it selfe must needes be accounted a notable quantitie.

Maister.

But if it shalbe so accounted in regarde to the halfe diameter of the skie, then must the starres ouer our heades seeme bigger by a notable quantitie, then when they are in the east or west.

Scholler.

That reason is not onely approoued by Geometry, but also by common sight and daily experience, that the nigher any thing is to the sight, the greater it seemeth: and the further from the sight, the lesser it sheweth.

Maister.

There

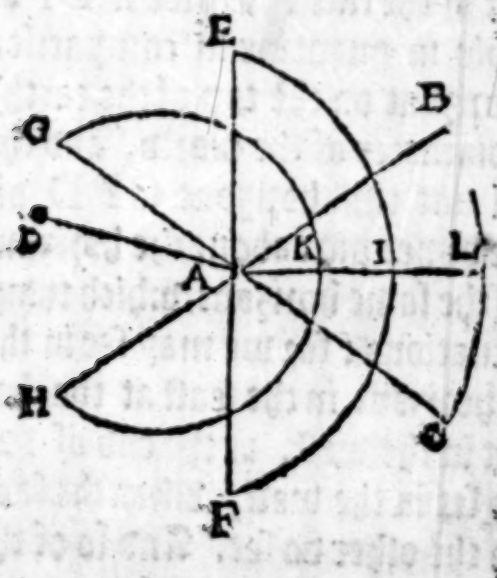
There is no ſuch diuerſitie perceiued in the quantitie of the ſtarres, but that they appeare ſtil conſtantly of one bigneſſe: wherefore it muſt followe, that their diſtance is all one in all partes of the ſkie, and then doth not the ſemediameter of the earth make any notable diuerſitie in diſtance: wherefore it muſt be thought that the quantitie of it is not ſenſible in compariſon to the ſemediameter of heauen, neither the circumference of it in compariſon to the circumference of the ſkie, and much more may not the whole quantitie of it be accounted ſenſible in reſpect to the whole quantitie of the world.

Scholler.

That followeth wel, for as I learned in Geometrie, if the diameters of any two globes, be in ſuch proportion that the greater doe containe the leſſer a thouſand times, then be their circumferences in the ſame rate: but the platforme of the greater is 1000000. fold greater then the leſſer: and the whole ſubſtance of the bigger globe, containeth the ſmaller globe, 1000000000. times.

Maiſter.

Undoubtedly it may be perceiued by ſight as well in dialles, as other greater inſtruments made for obſeruations, that the ſemediameter of the ſun his ſphere is more then a thouſand times longer then the ſemediameter of the earth, elſe would not the ſhadows agree ſo exactly as they do: for they moue as duely and orderly about the centre of all ſuch inſtruments, as if their center were the very center of the world: which thing could not be, if thoſe two centres did differ notably, in reſpect to the ſphere of the ſunne. And if it were not, that an introduction doth not admit the exact proofes of the Art, I could hereby declare the proportion of theſe two ſemediameters ſo exactly, that you ſhould confeſſe that proofe to be right certaine and good. But now will I proceede to the declaration of this third reaſon by linearie demonſtration, although it be ſomewhat obſcure, without other help.



The third reaſon.

In this figure, which repreſenteth the three notable circles in a diall, that be made by the courſe of the ſunne, in the three notable places of the zodiake, that is in the two tropikes and in the equinoctial, the vttermoſt arke B L C, repreſenteth the tropike of Capricorne, and is here made no bigger then the quarter of a circle, becauſe the ſunne doth ſhine but ſixe houres vnto vs, when he is in the ſigne: the equinoctial is ſet as halfe a circle, becauſe the ſunne being in it, doth ſhine to vs twelue houres, and is here limited by E I F. The tropike of Cancer containeth three quarters of a circle, becauſe that when the ſunne is in it, then is there eighteene houres from ſunne riſing,

to sunne setting: and that circle here is signified by G K H. The centre of this diall is A, and the stile that giueth the shadow is D A, whose toppe being D, doth describe those cancilles or circles, in such preciseneſſe, as if that diall stoode in the centre of the earth: & likewise the distinction of the houres is such exactly in that diall, as if the centre of the diall were the very centre of the world.

Scholler.

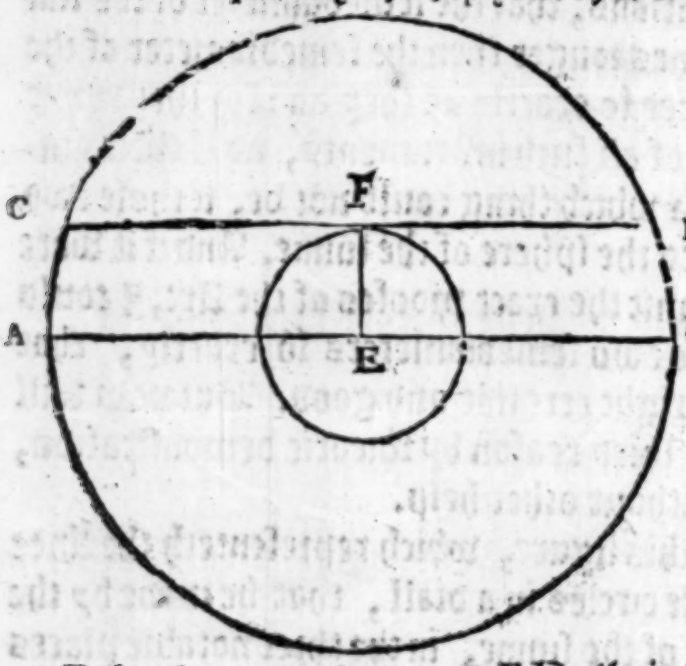
I doe conceiue good reason of proofe hereby, but yet I thinke I shall perceiue much more, when I shall vnderstand the iust vse of those dialles, aswell as of other seuerall instruments of like vse.

Maister.

You say trueth: and therefore will I passe from this third reason, and come to the fourth proofe, which is this.

The fourth reason for the smalneſſe of the earth.

If the earth were of any bigneſſe in comparison to the world, then shoulde his semediameter beare some view of bignes to the semediameter of the skie, and so consequently the horizont that we haue on the vpper part of the earth, should not diuide the skie into twoo equall partes, for that parte which should be vnder the horizont, would alwaies be the greater, and the lesser part aboue the horizont, as in this figure doth appeare, where A C D B is the circle of the skie, and the lesser circle is the earth, the center E being common centre to them both: and E F is the semediameter of the earth, as E A is the semediameter of the skie. Nowe if E F be notable in quantitie in comparison to E A, then will the line C F D (being the horizont on the top of the earth) differ notably from the line A E B, being the diameter of the world, and the horizont to the centre of the earth. And so shal not that horizont C F D diuide the world into two equall halfes, but the vpper part aboue the horizont shalbe lesser then the other part that is beneath the same horizont, which thing is contrary to daily experience, and to all obseruations: for we may see in the long winter nights those starres that be in the horizont in the east at the beginning of the night, to be in the same horizont in the west, at the end of 12. houres: and contrarywise those starres that did set in the west, when those other did rise in the east, shall rise againe when the other do set. And so of the sunne and the moone when they be in contrary points of the zodiake.



Scholler. That is at the full of the moone.

Maister.

Maiſter.

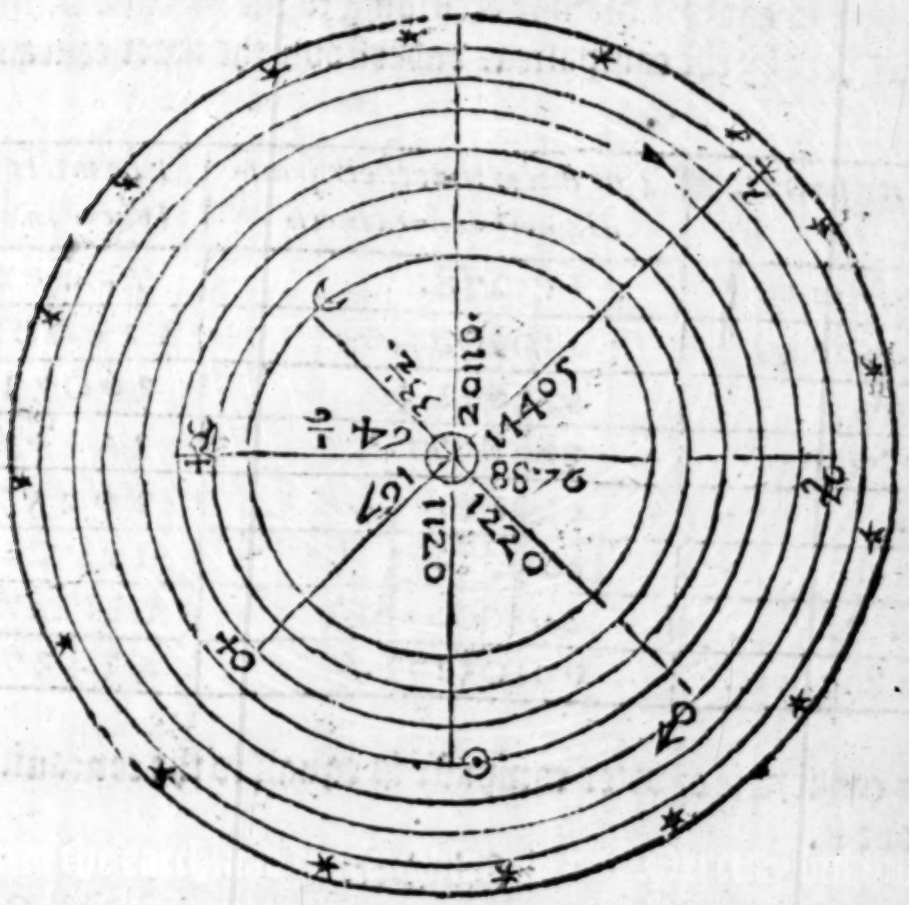
Indeed then are they right oppoſite the one againſt the other : but if the moone be at the full, long before the ſunne ſetting, then will ſhe riſe ſomewhat after the ſame : and contrariwiſe if ſhe be at the full after the ſunne ſetting, then will ſhe riſe ſomewhat ſooner, by reaſon that ſhe moueth Eaſtward euerie houre 33. degrees. And although vnto them that be meanly acquainted with the motions of the planets, the declination of the moone and her latitude, may occaſion ſome doubtfulneſſe to riſe, yet vnto the learned, thoſe manifold varieties in the motion of her and the other planets, doe confirme the principles of Aſtronomie more aſſuredly : but this will I omit till another more conuenient time.

Scholler.

This is well proued now, that the earth in compariſon to the whole world is but a pricke or a mote, and likewiſe in compariſon to the other ſpheres.

Maiſter.

You muſt except the ſpheres of the three planets which be beneath the Sunne : for vnto them the diameter of the earth beareth a notable quantitie: for the ſemediameter of Venus ſphere is but 167 times ſo long as the ſe-



miſdiameter of the earth: and the ſemidiameter of Mercury his ſphere is ſhorter much, for it is little more then 64. times the ſemidiameter of the earth: but the moone hath her ſemidiameter only 33. times and a halfe longer then

the earthes semidiameter: all which proportions with the residue, I haue set forth in this figure, whereby you may perceiue, that vnto the semidiameter of ech sphere, is annexed the number that importeth how often it containeth the semidiamiter of the earth. That is to say: the sunne his semidiameter containeth it 1120 time, Mars 1220 times, Iupiter 8876 times, Saturne 14405 times: and the eight sphere or starry skie, 20110. times.

Scholler.

I remember that Faber on the Sphere doth accompt those distances by miles, which is a pleasant matter to read.

Maister.

In that place Faber followeth the accompt of Alphraganus the Arabitian, which speaketh of miles much longer then the Italian miles be: for 6 of the Italian miles doe make but 5. of Alphraganus miles: of which diuersitie at another time I will instruct you, namely in the treatise of Cosmography: where I will set forth diuers varieties and appearant repugnances of sundry writers, for the measuring of the earth: and proue it to be a disagreement more in wordes then in meaning: and to come by reason of their diuers miles, or other inconstant measures. And because you like that table so well, loe here is another drawne according to the rate of 60. miles to eche degree. But here by the compasse is vnderstood the inner concauitie of eche sphere.

The eight spheres.	*The miles that their semidiameter containeth.*	*The miles of euerie sphere in compasse.*
☽ The Moone.	115278.	724604 $\frac{4}{7}$
☿ Mercurie.	220500 $\frac{2}{11}$	1386000 $\frac{4}{231}$
♀ Venus.	572872 $\frac{8}{11}$	3607200
☉ The Sunne.	2848267 $\frac{3}{11}$	24189727 $\frac{1}{2}$
♂ Mars.	4192262 $\frac{7}{11}$	26252000
♃ Iupiter.	30501163 $\frac{7}{11}$	191721600
♄ Saturne.	49500818 $\frac{2}{11}$	311148000
The 8 sphere.	69105272 $\frac{8}{11}$	434276000

And his conuexitie or vtter compasse is equall to the concauitie of the next sphere aboue it.

Scholler.

If the whole circuit of the skie be 434376000 miles, and the same compasse is 360 degrees: then must it needes followe, that euery degree of that skie containeth iust 1206600 miles, as by diuision it may be sufficiently well

well prooued. But howe is this supposition of distances approoued to be true.

Maister.

That prooke dependeth of more knowledge, then this introduction teacheth, and therfore must be referred to a higher treatise. But in the meane season admitting this supposition, you may easily tell, howe many miles the sunne and the moone are in breath, seeing eche of them is accompted about 31. minutes by their diameter, eche in the middle of his owne sphere.

Scholler.

Now I vnderstand the forme of working for triall of this matter. First I must search howe many miles make a degree in eche of those spheres, and then take a part proportionable of that number agreeable to 31 minutes & a half. Therefore to begin with the sunne. As his whole sphere in the middle is in compasse 25270868 miles, so trying it by diuision, I finde that euery degree in that sphere doth containe 70197 miles nigh hand. Then say I by the golden rule, if 60 minutes (which make one degree) doe require 70197, what doe 31 and a halfe make? After iust multiplication and diuision, as that rule doth import, I finde the whole diameter of the sunne to containe in miles, 368 53: where as the earth (as before is noted) doth containe in his diameter, but 6872 miles. So that thereby it appeareth, that the sun is more then 5. times so broad as the earth is ouerthwart.

25270868 (70197 2868/6060

60 Z 70197

31 1/2

70197
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368 53 (368 53

Maister.

That is well limited: for els if the flat of the greatest circle of the whole earth might appeare vnto vs, as the flat forme of the sunne doth, the flat forme of the sunne ought to be accompted about 29 times so great as the earth is, in like forme. And the whole globe of the sun must needes be about 155. times so great as the earth in his whole Globe.

Scholler.

Scholler.

I perceaue that both follow by two rules of Geometry, whereof the first is this.

In what proportion soeuer the sides of any two squares be, those squares are in the square of that proportion: so that if the sides be as 2 to 1, the squares are as 4 to 1: & if the sides beas 3 to 1, the squares are as 9 to 1, &c. The second rule is this: In what rate soeuer the sides of any cubes be, the cubes do beare the like rate cubikly multiplied. As if the sides be as two to one, the cubes are as 8 to 1: and if the sides be as three to one, the cubes are as 27 to 1. &c.

Maister.

This is well applied of you, that you can frame your common rules in Geometry to such special matters. And now may you proove the like in the Moone.

Scholler.

You say, that the circumference of the sphere of the moone is 724604. miles, and $\frac{4}{7}$: then diuiding it by 360, there will amount the quantitie of one degree: which yeeldeth in this rate 2012 miles and $\frac{71}{90}$: but accompting the breedth of the moone 31 minutes and a halfe, the miles that answere vnto it, are but 1057: whereby it followeth, that the diameter of the earth being 6872, is 6. times and a halfe greater then the diameter of the moone. And therfore the flat of the earth in his greatest circle, is aboue 42 times so great as the like flat forme in the moone: and the whole globe of the earth is 273 times so great, as the whole globe of the moone.

Maister.

In this accompt you take the innermost circumference of the sphere of the moone, and in the like accompt many other take the vttermost circumference, but it appeareth more reasonable to take the middle distance betweene them both, which is 1055302. (as here by example doth appeare) and in that place of distance to take the rate of hir diameter.

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Scholler.

So it seemeth most indifferent reason. And then the measure of one degree will be 2931 $\frac{71}{180}$ and of that there will answere to the diameter of the moone (being accompted 31 minutes and a halfe) 1529) miles. Now if I diuide the diameter of the earth (which is 6872) by it, there wil be in the quotient 4 and a halfe almost: so wil it appeare that the diameter of the earth is 4 times and a half almost so long as the diameter of the moon: and the flat of the earth 20. times so large as the flat of the moone. And the whole earth nintie times so great as the globe of the Moone.

Maister.

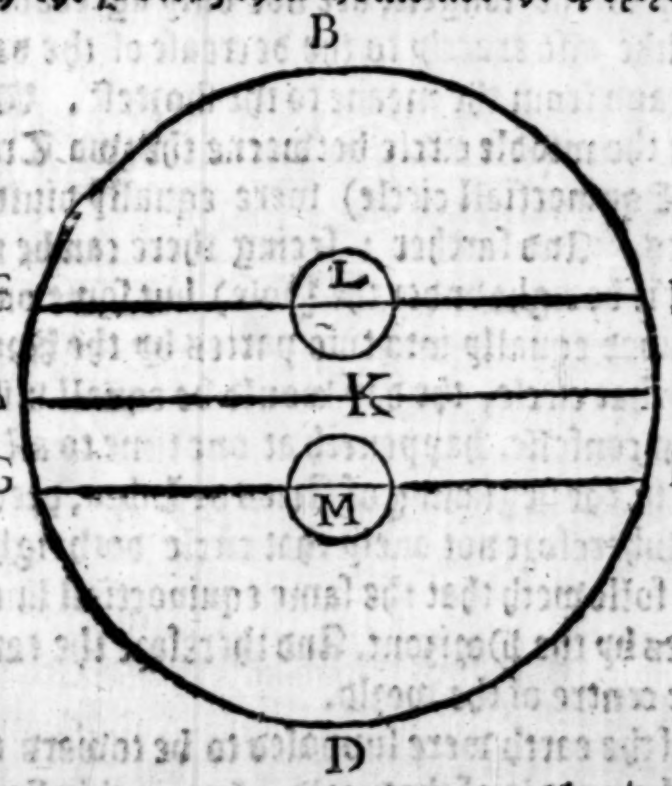
Maiſter.

Yet according to the common accompt, the earth is but 39. times ſo much as the moone: but heereof and of many other thinges that ſeeme aboue the reache of mans wit, I will another time inſtruct you farther: For it is no meet matter for an introduction. And this is brought for examples ſake only, that you might vnderſtand the order of ſuch ſort of working, and therby learn to try your authours ſayinges. But nowe it is time to proceede to other matters, and to declare the true place of the earth, and to prooue that it ſtandeth in the middle of the world: which thing although it may ſufficiently bee gathered by that that is written before, yet I will declare certaine inuincible reaſons for confutation of them that miſplace it. And to begin withall, there can be but three diuerſities of places in generall, without the centre of the worlde: for either it muſt be beſide the Axe-tree of the worlde, and yet equally diſtant from both the Poles, or elſe it muſt be on the Axe-tree of the worlde, and yet muſt be neerer to one Pole then to another: or thirdly, it muſt be beſide the Axetree of the worlde, and alſo neerer to the one Pole then to the other. Beſide theſe three varieties there is left but one more (which is the true placing of it) and that is to be on the Axetree of the world, equally diſtant from both the Poles: wherefore if the firſt three opinions be reproued as falſe; this fourth muſt needes remaine as only true. And now for the confuting of the three firſt opinions I will vſe Ptolomies arguments, augmenting them with a larger explication.

That the earth is in the middle of the world.

If the earth were out of the centre of the world, and yet ſtood in the middle betweene both the Poles, then ſhould not the Horizont cut the ſkie into

The confutation of the firſt opinion.



two equall halfes. And thereof would followe, that in the right ſphere the day and the night ſhould not be of one length. As for example: If I would

imagine the earth to stand as L doth in this figure: then would the Horizont be the right line E L F, and so the part that is vnder the Horizont is greater then the other part of the skie aboue the Horizont: wherefore in the right sphere the night must needs alwaies be longer then the day. But if you wold imagine the earth to stand where M, is set vnderneath K, which is the verie centre of the world: then would that Horizont G M H, which answereth to that centre, be vnder the true Horizont of the centre of the world, that is the right line A K C. And so should the night alwaies in the right sphere bee shorter then the day, because the greater part of the skie is aboue the horizont, and the lesser part vnder it. And by the like reasons in all other bowing spheres, there should be no equalitie betweene the day and the night: and if there were any, it should not be in that time when the sunne were in the iust middle betweene the two Tropikes, (that is vnder the Equinoctiall line) because that the Equinoctial line is not equally parted by the Horizont, but the greater part is aboue the Horizont, after the one supposition, and after the other supposition it is vnder the Horizont of the earth.

Scholler.

This I doe vnderstand well, accompting the circle A B C D, to represent the Equinoctial line.

Maister.

And farther you may perceiue (as all men, in all ages, and in all nations doe confesse) that the increase of the dayes from the shortest to the meane, and from the meane day to the longest, are not only agreeable betweene themselues, but are like also exactly to the decrease of the daies from the longest to the meane, and from the meane to the shortest. Which thing could not be, except that the middle circle betweene the two Tropikes (which is rightly called the Equinoctiall circle) were equally diuided by the horizont into two iust halues. And farther: seeing there can be no position of such obliquitie (except it be right vnder the Pole) but some one circle of the suns course must be diuided equally into two partes by the horizont, so that when the sunne were in that circle, the day would be equall with the night: which thing as al nations confesse, happeneth at one time to all men: and that is when the sunne is in the beginning of Aries or Libra, precisely vnder the Equinoctiall line: wherefore not onely that circle doth rightly agree with his name: but also it followeth that the same equinoctiall line is equally parted into two iust partes by the Horizont. And therefore the earth must needes be iudged to be in the centre of the world.

Furthermore, if the earth were supposed to be toward the East or toward the West, from the middle of the world, (as in this figure it is set toward the East, which is limited by A) then as the space toward the one side is shor-

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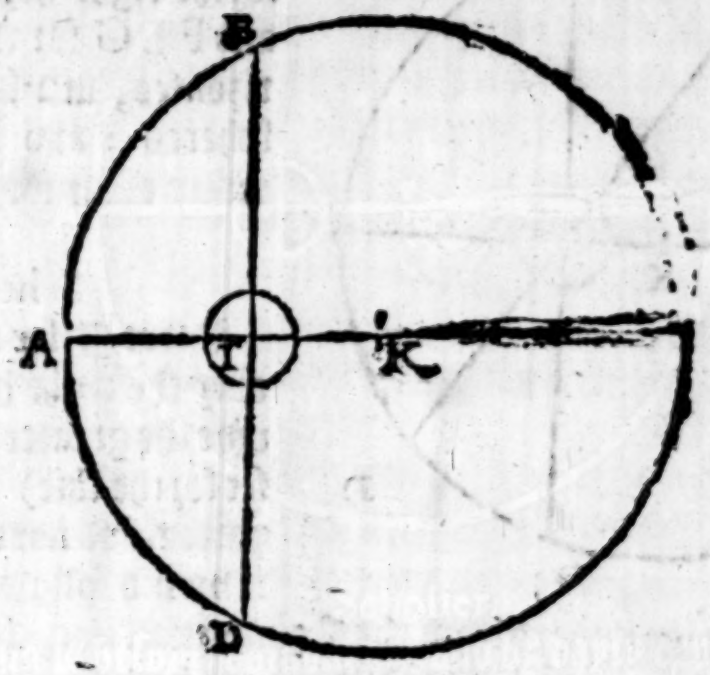
ter then the ſpace to the other ſide from the earth, ſo the Starres woulde ſeem bigger in that neerer part, and leſſer in that further part.



Scholler.

Which thing is before reproued, and by dayly experience may bee confuted.

Maiſter.

Therefore cannot it be a true opinion, that inferreth ſo falſe a concluſion. And yet there would follow of it more abſurditie: that from the morning vntill noone ſhoulde bee ſhorter time, or els longer then from noone vntill night.

Scholler.

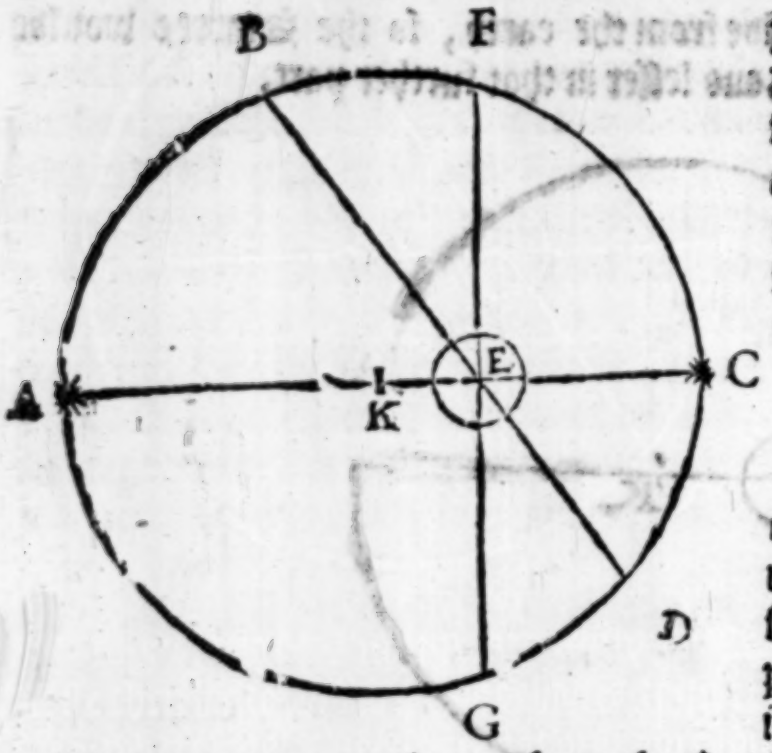
That muſt needes follow alſo, ſeeing that noone is that time of the day, when the ſun is in the circle, which goeth right ouer our heades from ſouth to north, which here in this figure is repreſented by the right line B E D, as I gather by your former doctrine.

Maiſter.

You geſſe well. And by the contrary of all theſe you may conclude thus: that ſeeing the time before noone is equall to the time after noone, and the ſtarres appeare neither bigger nor leſſer in the Weſt, then they doe in the Eaſt: And that when the ſunne is in the Equinoctial line, the dayes are equall to the nightes, it followeth certainly, that the earth can be no waies out of the Axe-tree of the world. An abridged argument of all the premiſes.

And now for the ſecond opinion, I reaſon thus.

If the earth were on the Axe-tree of the worlde nigher to the one Pole then to the other, then would the Horizont only in the right ſphere diuide the ſkie into two equall parts, and in no form of bowing ſphere, as by this figure Againſt the ſecond opinion.



you may gather, where E standeth for the earth, and A E C for the right horizont. B E D and F E G for two oblique horizontes, in 2 seuerall bowing spheres: and K limiteth the centre of the world.

Scholler.

Heere I see manifestly, that only the right horizont doth diuide the greater circle (which is set for the skie) into two equall partes, and none other: whereby it would follow, that we which dwell 52. degrees northward from the Equinoctiall line, should seeme much lesse then halfe the skie: but that is falle, as it hath been oftentimes proued: wherefore I perceiue that opinion cannot be true.

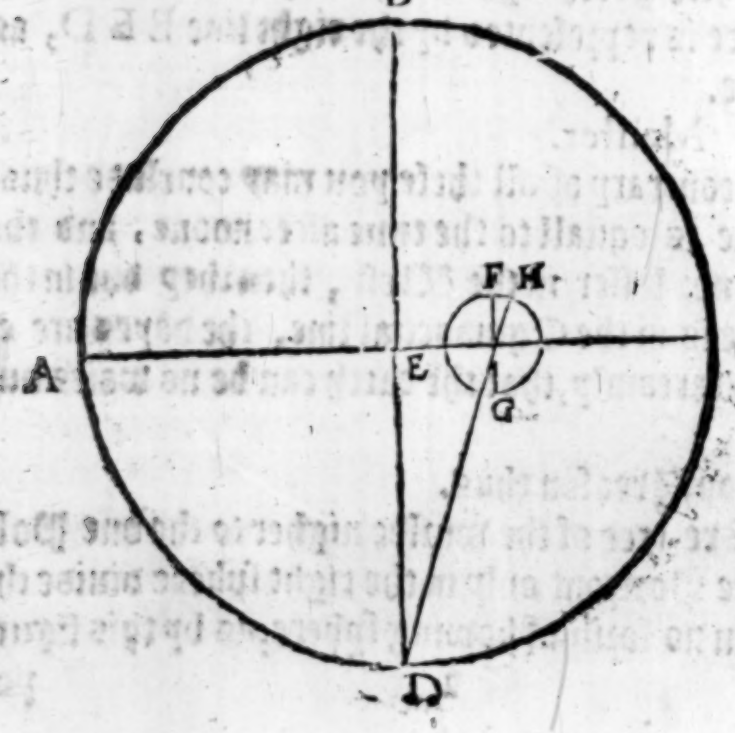
Maister.

An other argument against the second opinion.

Yet an other argument against that opinion, may this be. If the earth were nigher to the one Pole then to the other, when the sunne is in the iust East, the shadowes of anie things in Earth woulde not runne full West: but al shadowes in earth run ful West, when the sunne is iust East: (and contrarie waies:) therefore cannot the earth be nigher to one Pole, then to the other.

Scholler.

This argument is good, and the *minor* is well knowne to euerie sensible man: so is there no doubt but of the *maior*.



Maister.

For the proofe of it, I set this figure. Where the great circle A B C D betokeneth the Horizont, and the lesser circle E F G H standeth for the earth. The centre of the worlde is E: the east is D: and the west is B: the south is A: and the north is C. In the earth the line F G standes as a paralelle, with the right line B E D, and the right line D H

D H runnes croſſe them both, and makes an angle on the centre of the earth equall to the angle by D: whoſe largeneſſe is agreeable to the imagined diſtance of the centre of the earth from the centre of the worlde, wherefore the greater the diſtance is, the larger is the angle of that declination, and the leſſer diſtance, cauſeth a leſſer angle: but yet if the diſtance be any thing, then will that angle of declination be notable enough.

Sch. The reſt is eaſie to conſider: I meane that al ſhadowes run in a right line from the light body, that cauſeth that ſhadow, ſo that the ſunne being in D, which is the iuſt eaſt, would caſt the ſhadowes in the earth, not to F which is the weſt in the earth) but to H, which is almoſt northweſt: and therefore is your maiſter duely proued, and the ſecond opinion fully confuted. But how may the third opinion be anſwered?

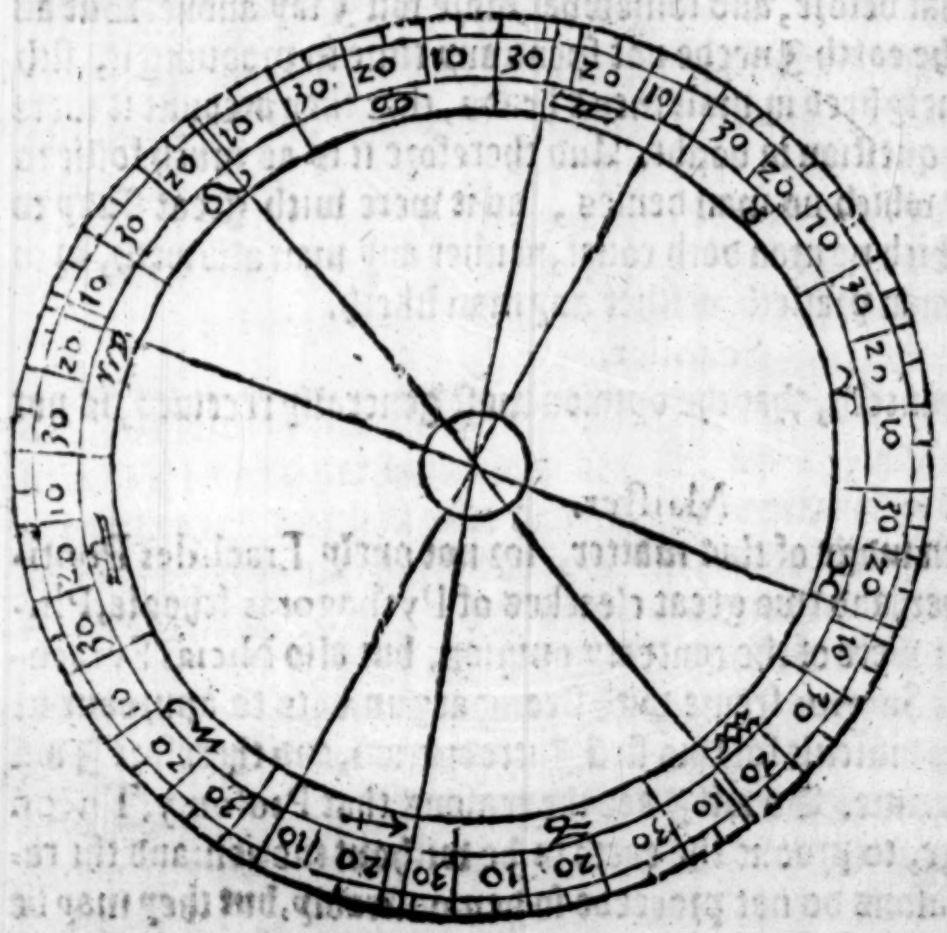
Maiſter.

The third opinion is, that the earth ſtandeth out of the axetree of the world, and alſo nearer to the one pole then to the other, ſo doth it containe both the other opinions: wherefore ſeeing they both are repꝛoued, this third muſt of neceſſitie ſeeme falſer then any of them both, becauſe it includeth all the vntrueth of them both. And therefore to conclude with Ptolomy, the increaſe and the decreaſe of dayes coulde neuer bee ſo ratable and iuſtly proportioned as they be, if the earth ſtoode any where elſe then in the verie centre of the world. And furthermore the eclipſes of the moone ſhoulde not happen (as now they do) at ỹ preciſe houre of full oppoſition, if the earth were not in the very centre of the world: for cõſidering that all the three bodies of the ſunne, the moone, and the earth muſt needs be in one right line (as in the doctrine of thoſe Eclipſes it is taught) there is no place in the world, where the earth may ſtande in that right line common to all ſuch Eclipſes, but onely the centre of the world: as for examples ſake I haue noted foure ſeuerall eclipſes

Againſt the third opinion.

A confirmation.

Another reaſon.



of the moone: the first was in the yeare of Christs incarnation 1551. the 20 day of February, when the sunne was about the 12 degree of Pisces, and the moone about the 12. degree of Virgo. The second eclipse was in the yeare 1553, the sunne being in the eleuenth degree of Leo, and the moone in the eleuenth degree of Aquarius. The third Eclipse happened on the fift day of June in the yeare of our Lord one thousand fiue hundred fiftie and fiue, the sunne being in the three and twentieth degree of Gemini, and the moone in the 23. of Sagittary. The fourth eclipse shall be in the yeere 1556 the seuenteenth day of November, at which time the sunne shall be in the fift degree of Sagittary, and the moone in the fift degree of Gemini. Now if you list to take more examples, for further triall you may so do: yet two seuerall eclipses serue aswel for this proofe as 10000. And then drawing lines for eth eclipse from the place of the sunne to the place of the moone, al those lines must needes passe by the earth, and there is none other point, whereby they all or any two of them can passe, but onely the centre of the zodiake, (which is the centre of the world) therefore must that centre of necessity be accounted the place of the earth. And this may suffice for this time touching the earth and his accidents, principally appertaining to astronomy: for although many other things are to be considered in it, they appertaine rather to philosophers or Cosmographers, then to Astronomers, and namely in the doctrine of the principles. As touching the distinction of the zones, I haue saide somewhat before, and somewhat more wil I say anone. But as for the quietnesse of the earth I neede not spend any time in proouing it, sith that opinion is so firmely fixed in most mens heads, that they account it mere madnesse to bring the question in doubt. And therefore it is as much follie to trauell to prooue that which no man denies, as it were with great study to dissuade that thing which no man doth couet, neither any man alloweth, or to blame that which no man praiseth, neither any man liketh.

Whether the earth moue or not.

Scholler.

Yet sometime it chanceth, that the opinion most generally receiued, is not most true.

Maister.

And so do some men iudge of this matter, for not onely Eraclides Ponticus a great philosopher, and two great clearkes of Pythagoras schoole, Philolaus and Ecphantus were of the contrary opinion, but also Nicias Syracusius, and Aristarchus Samius seeme with strong arguments to approoue it: but the reasons are too difficult for this first Introduction, and therefore I wil omit them til another time. So wil I vse the reasons that Ptolomy, Theon and others do alleadge, to prooue the earth to be without motion: and the rather, because those reasons do not proceede so demonstrably, but they may be answered fully of him that holdeth the contrary: I meane, concerning circu-

lare

lare motion: mary direct motion out of the centre of the worlde, ſeemes more eaſie to be confuted, and that by the ſame reaſons which were before alleadged for proouing the earth to be in the middle and centre of the worlde.

Scholler.

I perceiue it wel: for as if the earth were alwayes out of the centre of the worlde, thoſe former abſurdities would at al times appeare: ſo if at any time the earth ſhoulde mooue out of his place, thoſe inconueniences woulde then appeare.

Maiſter.

That is truely to be gathered: howbeit Copernicus a man of great learning, of much experience, and of wonderfull diligence in obſeruation, hath renewed the opinion of Ariſtarchus Samius, affirming that the earth, not onely mooueth circularly about his owne centre, but alſo may be, yea and is, continually out of the preciſe centre of the worlde eight and thirty hundreth thouſand miles: but becauſe the vnderſtanding of that controuerſie depends of profounder knowledge then in this Introduction may be vttered conueniently, I will let it paſſe till ſome other time.

Scholler.

May ſir, in good faith I deſire not to heare ſuch vaine fantaſies, ſo farre againſt common reaſon, and repugnant to the conſent of all the learned multitude of Writers, and therefore let it paſſe for euer, and a day longer.

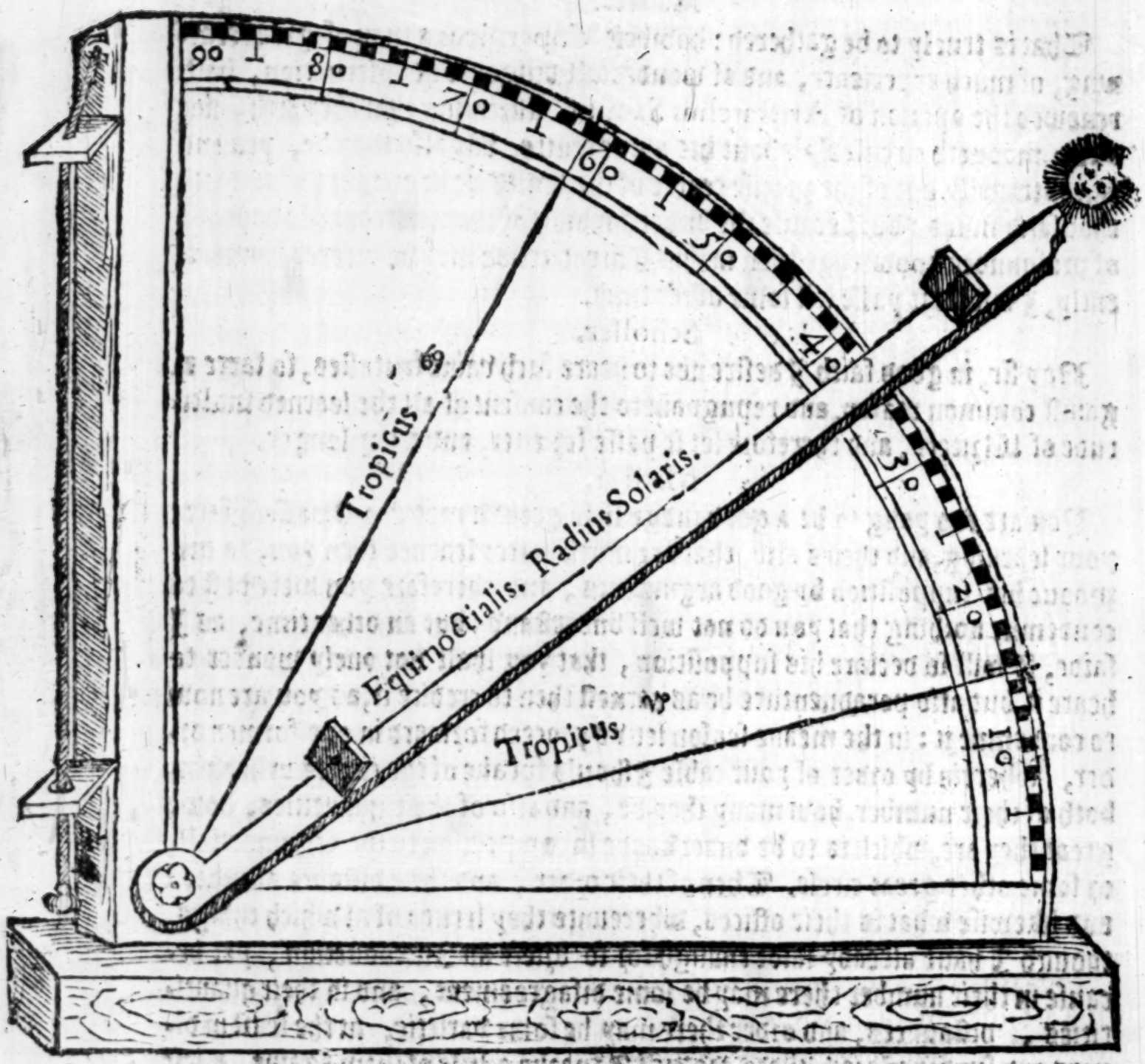
Maiſter.

You are too yong to be a good iudge in ſo great a matter: it paſſeth farre your learning, and theirs alſo, that are much better learned then you, to improoue his ſuppoſition by good argumentes, and therefore you were beſt to condemne nothing that you do not well vnderſtand: but an other time, as I ſaide, I will ſo declare his ſuppoſition, that you ſhall not onely wonder to heare it, but alſo peraduenture be as earneſt then to credite it, as you are now to condemne it: in the meane ſeaſon let vs proceed forward in our former order, wherein by order of your table I ſhould ſpeake of the circles in heauen, both of their number, how many they be, and alſo of their quantities, howe great they are, which is to be vnderſtoode in compariſon to the Equinoctiall, or ſome other great circle. Then of their order, and their diſtance aſunder: and likewiſe what is their offices, whereunto they ſerue: of al which things, though I haue already ſaide enough for ſo briefe an Introduction, yet becauſe in their number there may be ſome diſagreement, and in their quantities, diſtaunces, and order there may be ſome varietie, at the leaſt in diuers and ſundry places, therefore will I ſpeake a litle of them againe. Firſt for the equinoctiall, there is but one through all the worlde, and he is equally diſtant from eche pole, and therefore is called the Girdle of the ſkie: his office was declared before to be the limite of the middle of the worlde, in which the Equinoctiall.

lynes

ſunne makes the dayes equal to the nights. Alſo hee declareth the true eaſt and weſt, and is not onely the common meaſure whereby al other circles are iudged in quantitie, but alſo it is the true meaſure of motions celeſtiall, and the very rule to iudge all aſcentions by, as hereafter more largely ſhall appeare. Next vnto this circle are there two tropike circles, one on ech ſide of it, whoſe diſtance aſunder may wel be marked by a quadrant ſet ſo in place conuenient, that it may ſtand iuſt plumbe with the flat of the horizont, and be tur-

The tropikes.



ned ful ſouth. Then obſerue many dayes about the middle of June the higheſt point that the ſunne wil aſcend vnto, and ſhine duely thorough thoſe two ſights in the ruler, mouing it higher or lower, as occaſion ſerues, til it ſtand exactly

exactly pointing the height of the ſunne at noone beeing at the higheſt. The like obſeruation ſhal you make diuers dayes before, at, and after the middle of December, till you be aſſured of the iuſt height at noone of the ſunne, being at the loweſt then toward the ſouth. The points of theſe 2 obſeruations wel marked in the edge of the quadrant, are the true places of the 2 tropiks: and the diſtance of thoſe 2 markes aſunder by number of degrees, is the very true diſtance of the 2 tropikes. In the iuſt middle betweene theſe 2 tropikes is the place of the equinoctiall circle. Example: with vs, where the pole is 52 degrees high, the winter tropike will be 14 degrees and a halfe aboue the horizont, the ſummer tropike 61 and a halfe, and the equinoctiall iuſt 38 degrees in height. And the number of degrees that are betweene this equinoctiall and any one of the tropikes is named the Greateſt declination of the ſunne, which in our time is about 23. degrees and 28. minutes. The other points of declination of the degrees in the ecliptike line from the equinoctiall circle, becauſe they be many in number, and diuers in vſe, I thinke it good to expreſſe in a table which hereafter ſhall ſerue you for ſundry vſes.

The greateſt declination of the ſunne.

Scholler.

The like table is in Orontius.

Maiſter.

Not euen the like, as by conferring you may perceiue: but for the vſe of it, take what degree you liſt, of any ſigne, and by this table you may know his declination from the equinoctiall circle. The ſignes are written, partely on the head of the Table, and partly on the foote of the ſame, The degrees in the firſt columne do ſerue for the ſignes that be on the head of the Table, and the degrees in the laſt columne do ſerue for the ſignes in the foote of the table, and the common angle againſt the ſigne: and the degree that you ſeeke for, doth containe the degrees and minutes of the declmation due to it.

Scholler.

I perceiue it well: if I would know how muth the tenth degree of Leo declineth from the equinoctiall, I muſt looke in the columne ouer Leo right againſt the number of ten in the laſt columne, where I finde 17. 46.

Maiſter.

That is 17. degrees, and 46. minutes, which is the declination of the tenth degree of Leo from the equinoctiall circle.

Scholler.

I muſt alwayes vnderſtand, that ſixtie minutes doe make a degree: ſo theſe ſixe and forty minutes are $\frac{3}{4}$ of a degree and $\frac{1}{60}$ more. But what is the vſe of this table?

Maiſter.

That ſhal you know in the next Treatiſe: in the meane ſeaſon to proceede with the paralell circles: there followeth next, the Arctike and Antarctike circles,

The Arctike and Antarctik circles.

The Table of Declination particularly for euery degree of the Ecliptike line, and so for the sunne.

deg.	Aries Libra degr.	min	Difference min	Taurus Scorpius degr.	min.	Difference	Gemini Sagittarius degr	min	Difference	deg.
1	0	24		11	50	21	20	23	12	29
2	0	48	24	12	11		20	35		28
3	1	12		12	32	20	20	47	11	27
4	1	36		12	52		20	58		26
5	1	59		13	12		21	9		25
6	2	23		13	32		21	20	10	24
7	2	47		13	52		21	30		23
8	3	11		14	12	19	21	40	9	22
9	3	34		14	31		21	49		21
10	3	58		14	50		21	58		20
11	4	21		15	9	18	22	7	8	19
12	4	45		15	27		22	15		18
13	5	8		15	45		22	23	7	17
14	5	32	23	16	3		22	30		16
15	5	55		16	21		22	37		15
16	6	18		16	39	17	22	44	6	14
17	6	41		16	56		22	50	5	13
18	7	4		17	13		22	55		12
19	7	27		17	29		23	1	4	11
20	7	50	22	17	46	16	23	5		10
21	8	12		18	2		23	10		9
22	8	35		18	17		23	13		8
23	8	57		18	33	15	23	17	3	7
24	9	19		18	48		23	20	2	6
25	9	41		19	2		23	22		5
26	10	3		19	17		23	24		4
27	10	25		19	31		23	26	1	3
28	10	47	21	19	44		23	27		2
29	11	8		19	58		23	28	0	1
30	11	29		20	10		23	28		0
degr.	degr.	min.		deg.	min.		degr.	min.		deg

	Virgo Pisces	Difference	Leo Aquarius	Difference	Cancer Capricorn	Difference	

circles, which are in number two, and their office is to enclose those starres, which euer appeare aboue our horizont, or neuer appeare aboue the same, as before is declared: but because euery seuerall climate hath those circles disagreeing from other climates, therefore their distance from the other circles paralels can not be certaine, (but for one region certaine) neither yet their quantities, neither their order: for where the eleuation of the pole is lesse then 66. degrees and a halfe, there are those circles lesser then the tropikes, and are in order betweene them and the poles, being alwayes distant from the pole iust so many degrees as the pole is in height aboue the horizont in that region.

Scholler.

It cannot be otherwise: and therefore it followeth, that where the pole is more then sixtie fiue degrees and a halfe in height, there the tropike is aboue the horizont, as at Wardhouse you declared it to be: and therefore in that climate the Arctike circle is greater then the tropike of Cancer.

Maister.

Hereby appeareth the ouersight of most part of the Greekes in limitting the zones: for they appoint the Arctike and Antarctike circles for bounds of the temperate zones on the one side, and the tropikes on the other side: whereof neither bound can be well admitted, after their owne explication of the qualities of the zones, for if the temperate zones shall be called those zones that be inhabited, as they do so name them, then because there was knowen inhabitants innumerable by south the tropike of Cancer, it must needes follow, that the tropike can be no bound of the temperat zone: but yet otherwise accounting the distinction of the zones, not by that they are inhabited or vninhabited, but by the varietie of the motion of the sunne in respect to them, and by other accidents of shadowes, there may be good reason to make the tropikes bounds of the temperate zones: mary there is not the like reason for the Arctike and Antarctike circles: for confutation therefore of that opinion, I make this argument.

Of the fiue zones against the Greekes.

No vncertaine and variable bounds can limit any certaine place: the temperate zones are places certaine, and the Arctike circle with the Antarctike are changeable, and vncertaine limites. Therefore cannot they be the bounds of the temperate zones.

An argument in Ferio.

Scholler.

This is a good argument, made in *Ferio*, the fourth moode of the first figure. And the *maior* is most true, sith nothing can more disagree, then certaine and vncertaine, stable & vnstable, being contraries together. The *minor* hath 2. parts in it, which both seeme as true: for as long as the sunne keepeth one yearely course, so long the regions must remaine as they were, and that is for euer, either still temperate, or still vntemperate. And so

is that part of the *minor* true. The other part for the inconstancy and changeableneſſe of the circles Arctike and Antarctike muſt needes be true by their definitions, approoued of the ſame Greekes: for euery region hath a ſeuerall Arctike circle. Wherefore I maruell much that the Greekes being ſo wiſe men, and ſo greatly learned, ſhould be ſo much ouerſeene, and ſo fowly deceiued: but peraduenture there are but few of that opinion, and ſuch as were leaſt learned.

Maiſter.

Parmenides, Ariſtotle, Cleomedes and Proclus may not be accounted vnlearned, and yet they with many other haue written that as trueth. But hereby may you perceiue what folly it is, when men receiue any doctrine as true, and doe not well weigh it, but credite the authoritie of the firſt teacher. So it appeares in this matter, that becauſe Parmenides which was a great philoſopher, had firſt taught that diſtinction of the zones, all the reſt did follow his opinion as a plauſible doctrine, without examination of it, till Poſidonius beganne to eſpy that errour, and to confute it: as Strabo doth declare in his ſecond booke of Geography, which place in the latine tranſlation is ſo ill expreſſed, that no ſentence in it importes any ſence: wherefore aſwell for the commoditie of you as of other, I will ſomewhat amend that place, wiſhing them that haue leiſure and learning, to helpe to amend many other faults of that good booke and other like. The Latine tranſlation is this:

A place of Strabo amended.

Ad Septentriones, neque penes omnes exiſtentem, neque eiſdem vbicunque. Quiſnam temperatas quæ immutabiles ſunt diuideret? Cum igitur non penes vniuerſos ſit ſeptentrionales eſſe, nihil eſſet ad argumentum: ſi enim penes habitatores temperatæ omnes, ad quos dicitur, ſolos temperata? Quod autem non vbique eodem modo, ſed mutari bene comprehenſum eſt: ipſe autem in zonas partiens, quinque ad cœleſtia quidem vtiles eſſe aſſerit. Ex his duas circumſtantes ſubter polos vſque ad eas quæ ſeptentrionales habent tropicos, diuerſarum vmbrarum eſſe ab alijs duabus, quæ deinceps ſunt vſque ad habitantes ſub polis. Quæ vero inter tropicos eſt, vtrinque vmbras habere.

Scholler.

Either the matter is very obſcure, or elſe there wanteth light in the declaration of it.

Maiſter.

There is little ſence in all theſe words: and that ſence that may bee gathered of it, is verie falſe. And yet is the Greeke booke both vncorrupt (except it be in a worde or twoo) and full of perfect, ſenſible, and pleaſant ſentences: and is thus in Latine.

Arcticis vero circulis (vt qui nec apud omnes exiſtant, nec ijdem vbique perſeuerent) quis vnquam temperatas zonas (quæ immutabiles ſunt)

ſunt) terminaret? Cæterum illud, quod non apud omnes exiſtant Arctici circuli, nihil facit ad reprehenſionem. Quum ſatis ſit, ſi modo ſint apud omnes incolas temperatæ ipſius zonæ, ad quos ſolos temperata dicitur. Quod verò adiecit, non vbiq; ſeruare eos eandem rationem, ſed variè mutari, hoc quidem rectè adſumptum eſt. Atq; ipſe Poſidonius dum Zonas diſtinguit, quinq; inquit vtiles eſſe ad cœleſtes obſeruationes. Quarum duæ, quæ Polis ſubiacent, vmbras circumfluas habent, vnde Periſciæ dicuntur: ibiq; finiuntur vbi tropici ipſi pro arcticis circulis habentur. Has ſequuntur aliæ totidem, eò pertingentes, vbi Tropici verticibus incolarum imminent, atq; in his vmbræ meridianæ in vnum plagam porriguntur ſemper, hinc Hetoroſciæ vocantur. Quanta verò quæ inter tropicos iacet, in vtrumq; latus vicisſim vmbras mittit, atq; Amphiſcia nuncupatur.

Which wordes may be engliſhed thus. What man (ſaith Poſidonius) would aſſigne the arctike circles to be as boundes to the temperate zones: ſeeing thoſe circles are not in euery climate: neither doe they continue vniforme and of one fort to all countries. These wordes (ſaith Strabo) that they be not in euery climate, maketh nothing to the reproof: for it is ſufficient that they be incident to all the inhabitantes of the temperate zone, in reſpect to whom alone that temperate zone beareth his name: but thoſe other wordes, that they keepe not one vniforme maner in all places, but are diuerſly changed: that is well alledged. Alſo Poſidonius himſelfe when he diſtincteth the zones, doth ſay, that fiue zones are needfull and ſufficient for celeſtiall obſernations: whereof two which be vnder the Poles, are called Periſciæ, or Round ſhadowed, becauſe their ſhadowes run round about them. And theſe zones extend to that place, where the tropike circles and the arctike circles are all one. After theſe two there doe followe two other, which reache from thence vnto thoſe partes that are directly vnder the tropikes: and theſe haue their noone ſhadow running one waies ſtil, and therefore are called Heteroſciæ, or ſingle ſhadowed. The fift zone lieth betweene the tropikes, and caſteth the noone ſhadowes two waies, wherefore the Greekes call it Amphiſcion, that is double ſhadowed.

Scholler.

By this tranſlation (which is worth a paraphraſis) I doe not onely perceiue the ſence of theſe wordes, which before were darke, partly for the hardneſſe of the matter, and partly for the hypallage, in chaunging of the ſpeakers perſon: but alſo I eſpie the monſtrous ſhape of the olde tranſlation. And by this I gather alſo, that Strabo woulde not haue the temperate zones to be bounded by the arctike and antarctike circles.

Maiſter.

This minde appeareth more manifeſt anon after, where he blameth Polybius, for aſſigning thoſe circles as boundes of the zones: whereof one ſhould

be inclosed within that circle, and the other should extend from it to the next tropike. Then he concludeth thus : that those vnconstant circles may be no boundes of certaintie.

Dictum enim est, quod per signa transmigrantia, ea quæ non mutantur, terminare non conuenit.

For I haue said before, that changeable limites may not be appointed as boundes to vnchangeable places.

Scholler.

Thus it appeareth, that the distinction of zones by the Arctike and Antarctike circles were no constant distinction, and so is authoritie of one sorte repelled by the authoritie of an other sorte.

Maister.

You may not weigh the matter by authoritie: for so should that former doctrine continue still, seeing I alledged for it Parmenides, Aristotle, Polybius, Cleomedes and Proclus, and against them onely Posidonius and Strabo, which may seem the weaker in number: but then consider that the first sort bring only affirmation for their testimonie, and bare authoritie: the other, confute them by good reason and substantiall argumentes, which are farre to be esteemed aboue any authoritie.

Scholler.

Then crediting reason against authoritie, I must say, that the zones must be otherwise diuided, peraduenture as I did learn of you before, agreeable to *Iohn de Sacro Bosco* his minde, whom you called the restorer of the Zones.

Maister.

Yea indeed: for although Posidonius and Strabo did teache the like distinction, yet did they not so openly name the true limites, howbeit in effect they meane the same: for when Strabo saith, that the colde zone doth reach to that place, where the tropike is the arctike circle, hee doth meane, that there where this first zone endeth, and the temperate beginneth, the Pole is 66. degrees and a halfe aboue the horizont, and so must the same Pole be from the top of their heades in that place 23. degrees and a halfe: in which distance because the poles of the Zodiake doe describe a circle, therefore doth *Iohn de Sacro Bosco* call that circle the Arctike circle, in that confounding it in name with another circle of the Greekes: wherefore I thinke it more reasonable for auoiding confusion, to giue it a seuerall name, and call it the Polare circle, and the other to be called still the article circle, as the Greekes long before did name it. And this distinction of the Zones by the two tropikes, and the two Polare circles doth distinct exactly those three varieties of shadows before mentioned. Which is a certaine and notable difference, not imagined by men which may erre, but wrought by the sunne, which cannot erre. But

The Polare circles.

here

here muſt I admoniſh you of another errour, gathered not of grounded reaſon, but of phantaſticall imagination, by occaſion of which, this fond diſtinction of Zones was imagined. An other error

Becauſe the elder Greeks had no trade into the South partes of Afrike, neither the Ethiopians again into Greece, and further by reaſon the ſunne runneth ſtill ouer their heades that dwell betweene the tropikes, many of the Latines as wel as of the Greeks phantaſied, that there did dwell no inhabitants, neither could dwel there for the vehement heate: wherefore they called it the Burned Zone. And of like occaſion were they mooued to accompt two other zones, that be nigh the poles, to be vninhabited for colde, by reaſon that the Sunne doth neuer come nigher to them then the Tropike circles: but how much herein they were deceiued, it may be declared not only by reaſon, and by experience, but alſo by authoritie of many of their owne writers, as namely Eratoſthenes, Poſidonius, Polybius, and Ptolomy. But as this is a matter more agreeable to the treatiſe of Geography or Coſmography, then of the Sphere, ſo wil I ouerpaſſe it for this time, and wil returne to the reſt of the circles of the ſphere, amongſt which the zodiake as principall doth offer it ſelfe, as the common Theater and ſtage of al the planets motion, and of the chiefe ſignes and celeſtiall figures. The zodiake.

Scholler.

Are there I pray you ſuch figures in the zodiake, as Aſtronomers doe deſcribe?

Maiſter.

There are ſome that affirme no leſſe, and teſtifie þ they haue in a cleere aire perceiued them: but for the reſt of the forme, I will ſay nothing now: only this I doe affirme which I know, that all the ſtarres which aſtronomers do name to be there, may eaſily be ſeene there, and in like forme as they do place them.

Scholler.

If the formes of beaſtes be not there, why doe they call it by that name of Zodiake, which name is deriued as many do affirme, of *Zodion*, that ſignifieth a beaſt.

Maiſter.

The Signes doe beare the names of beaſtes, and therefore may that circle take the like denomination alſo: but yet I denied not that the very formes were there, but that they are not eaſily ſeene in ſuch exact ſhape as they be portraied, and as ſome men write that they haue ſeen theem: but howſoeuer it be, the certaintie is, that the 12. ſignes are contained in that zodiake, and therfore doth Tully with other learned men call it Signifer: that is, the circle of the Signes: but why thoſe names were giuen to euery ſigne rather then other, doth not appertaine ſo much to this treatiſe, as to that Iudiciall arte, which hath more ground of reaſon then many men thinke.

Scholler.

Scholler.

When you say that the sunne is in any signe, you doe not meane (I am sure) that the sunne hath leapt so high from his owne sphere, into the sphere of the Fixed starres, where the zodiake and the signes be, but that the sunne is directly vnder the same signe, and a right line betweene that signe and the centre of the earth.

What is to be in a signe.

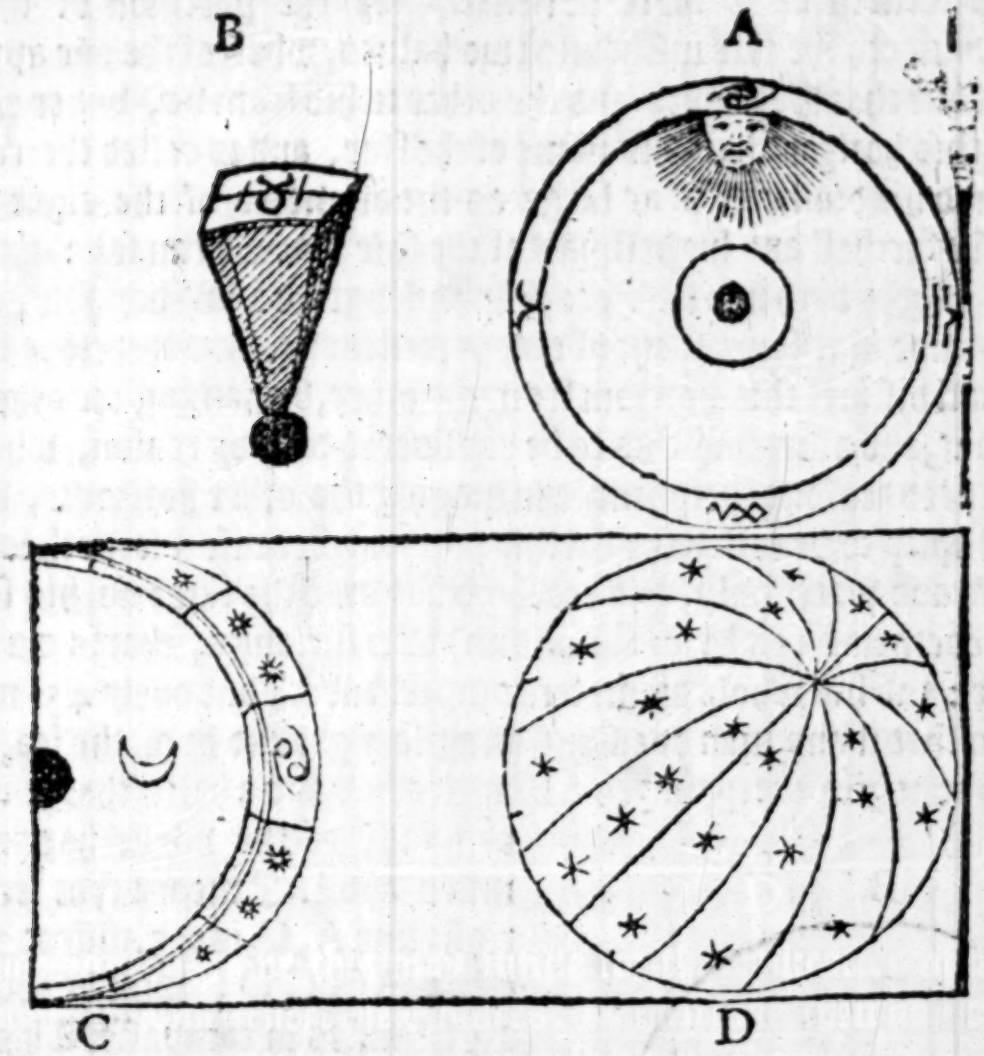
Maister.

You say well. That is the common vnderstanding, when wee speake of the place of the sunne: but because other Planetes doe decline from the middle of that zodiake, sometimes toward the north, and other times toward the South, therefore haue all astronomers appointed a conuenient bredth to the zodiake, according to declination of the Planets: howbeit properly they doe call that the Latitude of the Planetes, when they swerue from the Ecliptike line: and the Declination of them is their distance south or north from the equinoctiall line: so doe they call the motion of them in Longitude, their distance by their naturall course from the beginning of Aries, which is the beginning of the zodiake. And now appointing the latitude of the zodiakes be twelue degrees (although some planets may runne in latitude on the one side almost 8. degrees) because that quantitie is most receiued, then is euery signe twelue degrees broad, and thirtie degrees long, and so maketh a long square: from the corners of which long square, you may imagine lines to be drawne to the centre of the earth: and whatsoeuer commeth within the boundes of those lines, is accompted to be in that signe: and this is the second signification of a signe. A third signification there is, which wee vse when we say that, the bright starre Arcturus is in Virgine, whereas indeede he is aboue 30 degrees north from the ecliptike line: which is far out of the bredth of the zodiake: and so we say that the Pole starre is in Taurus, which is from the ecliptike line 66. degrees. And likewise wee name all the starres in the skie to be in some signe, be they neuer so farre from the Ecliptike line, and the zodiake. Therefore to know what is vnderstand by the name of a signe in this signification, you must imagine 6. circles to be so drawne about the globe, that they may passe by the beginning of all the signes (for euerie circle will serue for two signes being contrary one against the other) and so shall the whole zodiake and all the Globe also be parted into twelue equall partes, if you haue drawne those circles rightly, and that they doe passe all by the two poles of the zodiake. Nowe marke how those two lines that doe inclose any signe, are widest asunder in the middle of the Zodiake, and from thence toward eche Pole of the zodiake they come neerer and neerer, till they touch in the Pole it selfe. All the space betweene any two such semicircles from one Pole to the other, is named a signe in the third signification: so that whatsoeuer starres be within that space, are named to be in that signe which

The Latitude of Planets.
Their declination.
Their Longitude.
The second signification of a signe.
The third signification of a signe.
Arcturus.
The Pole star.

is

within the ſame ſpace: of all theſe three diuers formes of ſignes here may you ſee examples. Of the firſt by A, where the ſun ſtandeth vnder the ſigne of Cancer. Of the ſecond forme you haue an example by B, and of the third ſort you haue two varieties, one by C, and another by D. So that whatſoeuer Planet hath come within the boundes of that figure B, is named to be in the ſigne of Taurus: and whatſoeuer Planet or fixed ſtar is within the compaſſe of the figure C, is iudged to be in Cancer: as the Moone is there repreſented to be, and al the Starres there portrayed: and ſo may you iudge of



any other ſigne. Nowe this may ſuffiſe for the explication of the zodiake, after whom followeth next the Colures, which take their names of vnperfectneſſe, becauſe they be neuer ſeene all aboue the ground in any oblique ſphere: whereby it appeareth, that good *Iohn de Sacro Boſco* was much deceiued in comparing them to the compaſſed bowing of a wild bulles taile, as though they tooke their names thereof: but men muſt beare with the ignorance of that time, for lacke of knowledge in the Greeke tongue. Theſe Colures ſerue principally for the diſtinction of the foure chiefe pointes in the zodiake, as before is declared. And becauſe the point of the interſection or croſſing of the ecliptike line and the equinoctiall, doth ſufficiently expreſſe two of thoſe pointes in the beginning of Aries and Libra: therefore the

Greekes doe assigne commonly but one Colure, for the other two tropike pointes, and none for these equinoctiall points. Howbeit, because they serue also for the declinations and latitudes of fixed Starres and Planets, I think it better to describe them, then to omit them. And thus haue I lightly touched al the circles that be fixed in the sphere, and moone with it. Nowe remaineth other two, which stand still alwaies and moone not, of which the

The horizont.

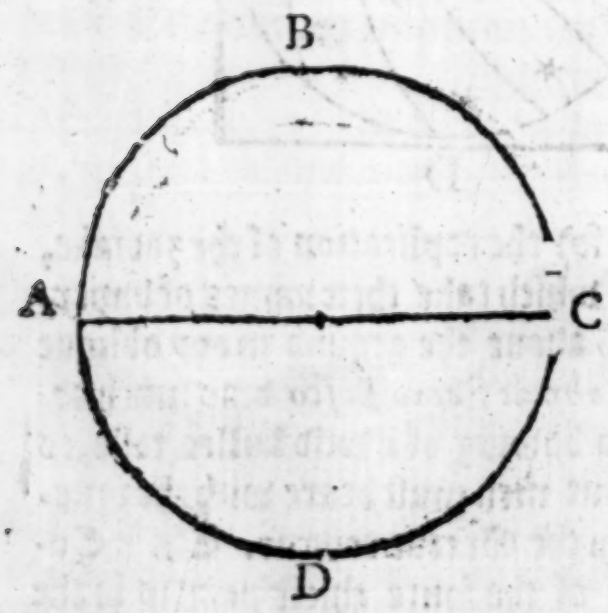
first is the Horizont, and the next is the Meridian. The Horizont is of two diuers sortes: the one doth extend on euery side vnto the firma-

The celestiall horizont.

ment, and serueth as it were peculiarly for the partition of the heauens, and diuideth the skie iustly into two halues, whereof the one appeareth vnto vs, aboue that Horizont, and the other is hid from vs, vnder the same Horizont: this horizont hath his name of the skie, and is called the celestiall

The earthly horizont.

horizont, and his diameter is as large as the diameter of the eight sphere, which is the farthest and highest part of the skie that we can see: this large horizont our sight doth inforce vs to acknowledge as a iust horizont, although reason can finde in it some want of exact precisenesse. And therefore Proclus doth not well distinct this horizont from the other, by naming the other a sensible horizont, and affirming this to be considered only by reason, whereas in deede wee need reasons helpe more in iudging the other horizont, which I think most aptly to be called the earthly horizont, because it serueth for sights on the earth and water only, and reacheth not vnto the skie: no, his semidiameter exceedeth not (as Macrobius saith) 180 furlongs, that is 22. miles and a halfe: and his whole diameter comprehendeth but onely 45. miles in length. So that if any man doe stand on a plain ground or on the sea, he may see round about him euery wayes 22. miles and and a halfe: that is in round



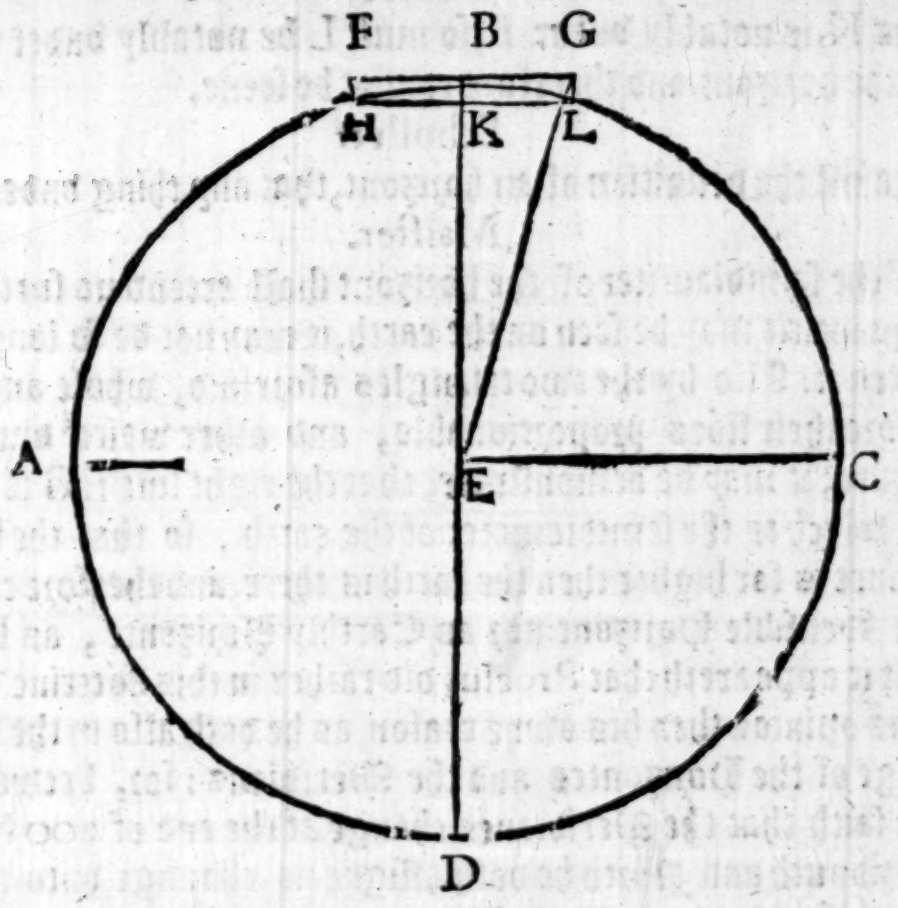
compasse of the whole horizont 141 miles and $\frac{3}{7}$. I meane that seeing the right line A, C, is 45. miles, ỹ whole circle A B C D, must be accompted 141 $\frac{3}{7}$ miles in compasse. This saying of Macrobius is more nigher to the truth then Proclus assertion, which is, that the diameter should be in this Horizont, 2000. furlongs, that is 250. miles, whereby he meaneth that a man may see euery way in a plaine, 125 miles from him: which assertion euery mariner doth know to be false: for it is well knowne by often and good obseruation, that in plaine ground, or on the sea, they cannot discerne well aboue 20. miles, and therefore doe all mariners call that distance commonly a

Kenning

Kenning: which is as much as a man may wel ſee: yet from a hill or high ground men may ſee further, and eſpecially they may ſee either hilles or cliffs, but that is no certain view, nor iuſt kenning: yet in that ſort men may ſee 60. miles, or at the moſt 80 miles: but 125 miles is too great a diſtance, for to view any thing from a high place, and therefore of more force it is too exceſſiue a diſtance to view any thing in an equall plaine, as the Horizont muſt needes be: for declaration whereof, I ſuppoſe this figure to repre-

A kenning.

A demonſtration againſt Proclus.



ſent the whole globe of the earth, and the earthly horizont to be expreſſed by the right line F B G: vnto which line there is another drawne as a iuſt paralelle, which is H K L: of like length preciſely with the earthly horizont, and two other lines ioyning them at the endes, making a long ſquare of all right angles, ſo that two of thoſe angles do light on the circumference of the circle of the earth. Then draw I a right line from E which is the centre of that circle, vnto B, and another from the ſame centre E vnto G: whereby there is made two triangles E B G, and E K L. Now preſuppoſing that B is the place where we ſtand on the earth, and H and L, the two extreme points on the earth, vnto which ỹ Semidiameter of 1000. furlongs of our earthly Horizont both extend on both ſides: and from the one of them is drawne a right line to the other, that line muſt needs fall within the circle.

Scholler. That is true, according to the 47 Theorem of the Pathway.

Maiſter. Then muſt the line K E, be ſhorter then the line B E, and ſo B and K, are notably diſtant.

Scholler. That is certaine,

Maister.

And because the right line FBG, is paralel to the right line HKL, there must be as much distance betweene G and L, as there is betweene B and K.

Scholler.

That followeth by the definition of Paralels.

Maister.

Then as K, is notably vnder B, so must L be notably vnder G: that is to say vnder the horizont, and therefore cannot be seene.

Scholler.

It is against the definition of an horizont, that any thing vnder it should be seene.

Maister.

Then if the semidiameter of the horizont shall extend no further then that a meane quantitie may be seen on the earth, it may not be so long as Proclus hath limited it. Also by the two triangles aforesaid, whose angles are like, and therefore their sides proportionable, and other waies diuerslie, by the former figure, it may be demonstrate, that the right line EG is much longer then EL, which is the semidiameter of the earth, so that the horizont in so much distance is far higher then the earth is there, and therfore cannot be aptly called a Sensible Horizont: nor an Earthly Horizonte, as Proclus meaneth. But it appeareth that Proclus did rather in this doctrine followe some other mens opinion then his owne reason, as he doth also in the declaration of the chaunge of the Horizontes and the Meridians: for, betweene East and West, he saith that the Meridianes change at the end of 300 furlonges: but betweene South and North he doth assigne no chaunge vnto the horizontes within 400. furlonges. In which wordes there are two errours included: the one that the horizontes be not like in chaunge betweene East and West, and betweene South and North.

Scholler. May he speaketh onely of the Meridians (I trow) betweene East and West, and not of the Horizontes.

Maister.

As though we might change the one, and not vniformely change the other.

Scholler.

Trueth it is, that seeing the Meridian doth cut the horizont with right angles, they both must needes either stand both still, or change both alike: wherefore this first errour cannot be excused.

Maister.

And the second errour is as manifest as it: for thereby he supposeth that the Climates doe chaunge by equall quantitie of furlonges or miles, which error is too manifest; for nigh vnto ỹ equinoctial, 2150 furlongs northward, doe

A Table for the difference of houres, according to the diſtance of miles from eaſt to weſt, vnder the Equinoctiall.

The diſtance of miles.	The minutes of an houre	The diſtance of miles.	Houres.	The minutes of an houre	The diſtance of miles.	Houres.	The minutes of an houre	The diſtance of miles.	Houres.	The minutes of an houre
15	1	465	0	31	915	1	1	1365	1	31
30	2	430	0	32	930	1	2	1380	1	32
45	3	495	0	33	945	1	3	1395	1	33
60	4	510	0	34	960	1	4	1410	1	34
75	5	525	0	35	975	1	5	1425	1	35
90	6	510	0	36	990	1	6	1440	1	36
105	7	555	0	37	1005	1	7	1455	1	37
120	8	570	0	38	1020	1	8	1470	1	38
135	9	585	0	39	1035	1	9	1485	1	39
150	10	600	0	40	1050	1	10	1500	1	40
165	11	615	0	41	1065	1	11	1515	1	41
180	12	630	0	42	1080	1	12	1530	1	42
195	13	645	0	43	1095	1	13	1545	1	43
210	14	660	0	44	1110	1	14	1560	1	44
225	15	675	0	45	1125	1	15	1575	1	45
240	16	690	0	46	1140	1	16	1590	1	46
255	17	705	0	47	1155	1	17	1605	1	47
270	18	720	0	48	1170	1	18	1620	1	48
285	19	735	0	49	1185	1	19	1635	1	49
300	20	750	0	50	1200	1	20	1650	1	50
315	21	765	0	51	1215	1	21	1665	1	51
330	22	780	0	52	1230	1	22	1680	1	52
345	23	795	0	53	1245	1	23	1695	1	53
360	24	810	0	54	1260	1	24	1710	1	54
375	25	825	0	55	1275	1	25	1725	1	55
390	26	840	0	56	1290	1	26	1740	1	56
405	27	855	0	57	1305	1	27	1755	1	57
420	28	870	0	58	1320	1	28	1770	1	58
435	29	885	0	59	1335	1	29	1785	1	59
450	30	900	1	0	1350	1	20	1800	2	0

doe cause increase but of a quarter of an hower in the longest day. And with vs in the South part of England, 700. furlongs Northward doeth cause increase of a quarter of an hower in the longest day, and in the North partes of Scotland, 320. furlongs doe giue as great an increase: in Island 4. furlongs yeeldeth the like increase: and so still the farther North you go, the smaller space of ground bringeth the like increase in the longest day.

Scholler.

Hereby I perceiue, that who so euer will trauaile in these sciences with profite, must leane rather to reason, thē to authoritie, els he may be deceiued.

Maister.

That rule is generall in all artes.

Scholler.

And if Proclus rule be not certaine, what rule may I haue more certaine?

Maister.

For the alteration of the Horizont betweene South and North, because not onely the climates doe change therewith, but also the quantities of the dayes, I will anone before the doctrine of the ascensions, giue you a table generall for all climates in the earth. And as for the change of the Horizonts or of the Meridianes betweene East and West, you shall vnderstand that 15. miles difference from East toward West, doeth make the sunne rising, the noone steed, and sunne setting, to be later by one minute of an houre, and so 30. miles 2. minutes: 120. miles 8. minutes: 225. miles, 15. minutes, which is a quarter of an houre. And for examples sake more then for any other cause I giue you here this table, which you may easily increase by the like forme, vntill you haue accomplished the whole 24. houres, if you list. howbeit he that is ready in account of Arithmetike, needeth not any such tables of aide. This table is calculate onely for such places as differ not aboue 1800. miles betweene East and West, hauing no difference or very little in their distances betweene South and North, as touching this consideration. And it serueth onely for the middle climate of the world vnder the equinoctiall circle. for euery other climate, yea, and euery degree in latitude of each climate, must haue a seuerall table, which may not well be set forth in this briefe introduction, but another time shall serue hereafter for it, if you call on me and put me in minde thereof, els the necessitie of prouision for my family, will make me forget such promises: howbeit, because you shall not thinke that I haue done more for them that dwell vnder the equinoctiall (or nigh vnto it in Guinea or in Calecut) then for our owne countrey, I haue drawen the like table for the eleuation of 52. degrees, whose vse is euen one with the other before. Wherefore if I know the distance of miles betweene any two places vnder this latitude of 52. degrees, or nigh thereto, as soone as I haue found out that number of miles in the table vnder that title, in the next

columne

A Table of the difference of houres, according to the diſtance of miles from eaſt to weſt, for the eleuation of 51 degrees, 55 minutes.

The diſtance of miles.	The minutes of an houre	The diſtance of miles.	The houres	The minutes of an houre.	The diſtance of miles.	The houres.	The minutes of an houre	The diſtance of miles.	The houres.	The minutes of an houre.
9 ¼	1	286 ¾	0	31	564 ½	1	1	841 ¾	1	31
18 ½	2	296	0	32	573 ½	1	2	851	1	32
27 ¾	3	305 ¼	0	33	582 ¾	1	3	860 ¼	1	33
37	4	314 ½	0	34	592	1	4	869 ½	1	34
46 ¼	5	323 ¾	0	35	601 ¼	1	5	878 ¾	1	35
55 ½	6	333	0	36	610 ½	1	6	888	1	36
64 ¾	7	342 ¼	0	37	619 ¾	1	7	897 ¼	1	37
74	8	351 ½	0	38	629	1	8	906 ½	1	38
83 ¼	9	360 ¾	0	39	638 ¼	1	9	915 ¾	1	39
92 ½	10	370	0	40	647 ½	1	10	925	1	40
101 ¾	11	379 ¼	0	41	656 ¾	1	11	934 ¼	1	41
111	12	388 ½	0	42	666	1	12	943 ½	1	42
120 ¼	13	397 ¾	0	43	675 ¼	1	13	952 ¾	1	43
129 ½	14	407	0	44	684 ½	1	14	962	1	44
138 ¾	15	416 ¼	0	45	693 ¾	1	15	971 ¼	1	45
148	16	425 ½	0	46	703	1	16	980 ½	1	46
157 ¼	17	434 ¾	0	47	712 ¼	1	17	989 ¾	1	47
166 ½	18	444	0	48	721 ½	1	18	999	1	48
175 ¾	19	453 ¼	0	49	730 ¾	1	19	1008 ¼	1	49
185	20	462 ½	0	50	740	1	20	1017 ½	1	50
194 ¼	21	471 ¾	0	51	749 ¼	1	21	1026 ¾	1	51
203 ½	22	481	0	52	758 ½	1	22	1036	1	52
212 ¾	23	490 ¼	0	53	767 ¾	1	23	1045 ¼	1	53
222	24	499 ½	0	54	777	1	24	1054 ½	1	54
231 ¼	25	508 ¾	0	55	786 ¼	1	25	1063 ¾	1	55
240 ½	26	518	0	56	795 ½	1	26	1073	1	56
249 ¾	27	527 ¼	0	57	804 ¾	1	27	1082 ¼	1	57
259	28	536 ½	0	58	814	1	28	1091 ½	1	58
268 ¼	29	545 ¼	0	59	823 ¼	1	29	1100 ¾	1	59
277 ½	30	555	1	0	832 ½	1	30	1110	2	0

columne on the right hand, I may see how many minutes they doe differ in their houres.

Scholler.

So that the miles exceede not 1110, for this table hath no greater number.

Maister.

If you list, by this president, you may increase the table as much as you will.

Scholler.

Because examples do make rules manifest, I pray you let me proove one example. London and Bristow are 94 miles asunder, and (as I haue heard you say) they are not much different in latitude: I desire to knowe their difference in houres, therefore I seeke for 94. vnder the title of distance of miles, and I cannot find it there, for 92. and a halfe is too little, and 101 ¾ is too great.

Maister.

And in like rate is there difference of minutes: for tenne minutes is too litle, and eleuen minutes is too great: but to ghesse most nearest: as 92 and a halfe is nigher to 94 then 101 ¾: so is 10 minutes more nearer their true difference then 11. And for this time this may suffice, although I can giue you a precise rule by the part proportionable to finde out the iust part of euery minute, but that were more curious then profitable in this place. Therfore will I leaue it, and declare vnto you, how you may make the like table for any latitude of euen degrees.

Scholler.

I do perceiue by these two tables, that if I haue once the first number that must be set against one minute of time, then must I double it for two minutes, and triple it for three minutes, and so forth, still multiplying the first number of miles by the number of minutes against which it shall stand.

Maister.

You take it well, and therefore seeing you doubt onely of the first number, I will giue you a table by which you may easily finde out that first number for all degrees of latitude of any region. And this is it, where in the first columne you see placed the degrees of latitude, and in the second columne are set the miles with their fractions, which serue for one degree of longitude, in ech of those diuers latitudes. By this table may you make any table for any eleuation of whole degrees, according to the example of the former two tables.

Scholler.

Of the climats

That do I perceiue now very well, and can do it, I doubt not, sufficiently for any climate, if I were as certaine of their boundes: but that may I learne

A Table declaring how many miles do anſwer to one minute of time, in euery ſeuerall latitude.

Degrees of latitude.	miles agreing to 1. minute of time.	Degrees of latitude.	miles agreing to 1. minute of time.	Degrees of latitude.	miles agreing to 1. minute of time.
0	15				
1	14 $\frac{250}{240}$	31	12 $\frac{108}{130}$	61	7 $\frac{14}{48}$
2	14 $\frac{70}{80}$	32	12 $\frac{194}{240}$	62	7 $\frac{1}{24}$
3	14 $\frac{47}{48}$	33	12 $\frac{139}{240}$	63	6 $\frac{97}{120}$
4	14 $\frac{7}{8}$	34	12 $\frac{21}{48}$	64	6 $\frac{69}{120}$
5	14 $\frac{13}{120}$	35	12 $\frac{69}{240}$	65	6 $\frac{81}{240}$
6	14 $\frac{11}{120}$	36	12 $\frac{2}{5}$	66	6 $\frac{1}{8}$
7	14 $\frac{7}{8}$	37	11 $\frac{47}{48}$	67	5 $\frac{207}{240}$
8	14 $\frac{41}{48}$	38	11 $\frac{197}{240}$	68	5 $\frac{149}{240}$
9	14 $\frac{40}{60}$	39	11 $\frac{79}{120}$	69	5 $\frac{3}{8}$
10	14 $\frac{37}{40}$	40	11 $\frac{52}{120}$	70	5 $\frac{31}{240}$
11	14 $\frac{87}{120}$	41	11 $\frac{77}{240}$	71	4 $\frac{58}{60}$
12	14 $\frac{81}{240}$	42	11 $\frac{7}{48}$	72	4 $\frac{12}{60}$
13	14 $\frac{3}{60}$	43	10 $\frac{213}{240}$	73	4 $\frac{31}{60}$
14	14 $\frac{1}{240}$	44	10 $\frac{10}{120}$	74	4 $\frac{3}{120}$
15	14 $\frac{117}{240}$	45	10 $\frac{73}{120}$	75	3 $\frac{53}{60}$
16	14 $\frac{101}{240}$	46	10 $\frac{109}{240}$	76	3 $\frac{51}{240}$
17	14 $\frac{83}{240}$	47	10 $\frac{11}{48}$	77	3 $\frac{3}{8}$
18	14 $\frac{4}{120}$	48	10 $\frac{9}{240}$	78	3 $\frac{7}{60}$
19	14 $\frac{11}{60}$	49	9 $\frac{101}{120}$	79	2 $\frac{207}{240}$
20	14 $\frac{23}{240}$	50	9 $\frac{79}{120}$	80	2 $\frac{10}{60}$
21	14 $\frac{1}{240}$	51	9 $\frac{53}{120}$	81	2 $\frac{83}{240}$
22	13 $\frac{109}{120}$	52	9 $\frac{7}{120}$	82	2 $\frac{7}{120}$
23	13 $\frac{97}{120}$	53	9 $\frac{1}{240}$	83	1 $\frac{199}{240}$
24	13 $\frac{60}{120}$	54	8 $\frac{49}{60}$	84	1 $\frac{17}{120}$
25	13 $\frac{145}{240}$	55	8 $\frac{29}{48}$	85	1 $\frac{37}{120}$
26	13 $\frac{29}{60}$	56	8 $\frac{93}{120}$	86	1 $\frac{11}{120}$
27	13 $\frac{1}{30}$	57	8 $\frac{1}{240}$	87	0 $\frac{47}{240}$
28	13 $\frac{58}{240}$	58	7 $\frac{1}{2}$	88	0 $\frac{30}{240}$
29	13 $\frac{29}{240}$	59	7 $\frac{87}{120}$	89	0 $\frac{13}{60}$
30	12 $\frac{112}{120}$	60	7 $\frac{1}{2}$	90	0

Of the climats

learne by such tables as Orontius and diuers others haue set forth already.

Maister.

The famous aduenture vnto Moscouia by the North Pean,

Indeede both Orontius and other haue set forth such tables, which may suffise for an introduction, but Orontius extendeth not his table aboue the latitude of 66. degrees and a halfe, so there resteth vnto the north Pole 23. degrees and a half, which coast hitherto hath been knowne to very few men, but nowe of late by the famous aduenture of that worthy companie of our English merchantes for Moscouia, that coast is discouered vnto 75. degrees of latitude nigh hand: and our hope is, that if they do continue as they haue valiantly begunne, they shal disclose those vnknowne people which dwel directly vnder the Pole, or at the leastwise discouer that climate, such as it is, to the ful satisfaction of that importune desire, which hath forced many thousandes to wishe, that which not one yet (that we know) could attaine: whereby they shal not only profite their countrey, but shall procure to themselues great riches and treasure: and that which is most to be desired, immortall fame. Wherefore for my part to further their knowledge in the atchieuing of their worthie attempt, as I haue alreadie in this booke giuen some light, so wil I (God willing) hereafter giue more light: and for an earnest thereof I will now exhibite to you a table of the climates extended to the very pole, whereby you may learne not onely the beginning and end of euery climate, but also the iust quantitie of the longest and shortest day in eche of them, and in al other places to the Pole-selfe: the reason whereof you shall better vnderstand by the diuersities of the ascensions.

But because (as I said before) that euery Climate differeth from other, by the space of halfe an houre in the quantitie of their longest day; therefore did the Greekes, and namely Ptolomy, for a more precisenesse make a certaine distinction for euery quarter of an houres difference, which hee calleth only by the general names of paralels, as it doth at large appeare in the first chapter of the second booke of his Almagestes, whereof at another time I will more largely intreate: And for this present time wil only set forth the summe of that matter in a table, whose first columpne doth containe the number of the paralels, as Ptolomy did distinct them. The second columpne containeth a more exact partition of those paralelles according vnto the increase of the longest day, by a quarter of an houre, which Ptolomy obserued not, after hee came to 18. houres of length: but I obserue still vntill 24. houres of length. After which time and place, because the increase of the longest day is greater and greater continually, I thinke it not good to make so curious a table for euery quarter of an houre, but (as Erasmus Reynholt doth) to make the distinction thencefoorth by halfe a degree of difference in eleuation of the Pole, as by the table you may see.

In

In this table are ſet forth 96 paralels iuſtly: and but 38 by Ptolomies partition: the cauſe whereof, I will ſhew you another time. Of theſe paralels are made 24 Climates betweene the Equinoctiall circle, and the tropike of Cancer: eche differing from other by halfe an houre, as the laſt columne of the table declareth: but the elder Greeks did not know very wel thoſe North countries, and therfore did they aſſigne only 7 climates according as I haue ſet them annexed to the firſt columne of this table. Howbeit, becauſe you

A Table for the iust distinction of Climates,

The number of the 7 climates according to the olde Greekes.	Parales after Ptol.	Parales more exact	Elevation of the pole. De.	Mi	The quantity of the longest day. H.	Mi	The Climates.	The names	Parales after Ptol.	Parales more exact	Elevation of the Pole. De.	Mi	The quantity of the longest day. H.	Mi	The Climates.
	1	1	0	0	12	0	1	of the 7. cli-	25	25	58	27	18	0	1
	2	2	4	18	12	15		mates after		26	59	15	18	15	
	3	3	8	34	12	30	2	some chiefe	26	27	59	59	18	30	1
	4	4	12	43	12	45		place in them		28	60	40	18	45	
1	5	5	16	44	13	0	3	by Meroe.	27	29	61	18	19	0	1
	6	6	20	34	12	15				30	61	53	19	15	
2	7	7	24	11	13	30	4	by Siene.	28	31	62	25	19	30	16
	8	8	27	36	13	45				32	62	55	19	45	
3	9	9	30	48	14	0	5	by Alex-	29	33	63	22	20	0	17
	10	10	33	46	14	15		andria.		34	63	47	20	15	
4	11	11	36	30	14	30	6	By the		35	64	10	20	30	18
	12	12	39	3	14	45		Rodes.		36	64	31	20	45	
5	13	13	41	23	15	0	7	by Rome.	30	37	64	49	21	0	19
	14	14	42	22	15	15				38	65	6	21	15	
6	15	15	45	31	15	30	8	by Pont		39	65	22	21	30	20
	16	16	47	21	15	45		Euxine.		40	65	35	21	45	
7	17	17	49	1	16	0	9	by Bori-	31	41	65	47	22	0	21
	18	18	50	24	16	15		thenes.		42	66	58	22	15	
	19	19	51	59	16	30	10	by Eng-		43	66	7	22	30	22
	20	20	53	17	16	45		land		44	66	15	22	45	
	21	21	54	30	17	0	11		32	45	66	21	23	0	23
	22	22	55	36	17	15				46	66	25	23	15	
	23	23	56	38	17	30	12			47	66	29	23	30	24
	24	24	57	34	17	45				48	66	31	23	45	
									33	40	66	31	24	0	

With

with the quantities of their longeſt dayes, and the Elevation of the pole.

Paralels after Ptol.	Paralels more exact	Elevation of the Pole. Deg.	Mi	Quantitie of the longeſt day. Dai	Ho	Paralels after Ptol.	Paralels more exact	Elevation of the Pole. De.	Mi.	Quantitie of the longeſt day. Dai.	Ho
	50	67	0	23	11		74	79	0	127	19
34	51	67	30	33	17		75	79	30	130	17
	52	68	0	41	14		76	80	0	133	13
	53	68	30	48	6		77	80	30	136	8
	54	69	0	54	3		78	81	0	139	3
	55	69	30	59	12		79	81	30	141	21
35	56	70	0	64	11		80	82	0	144	14
	57	70	30	69	4		81	82	30	147	7
	58	71	0	73	13		82	83	0	150	0
	59	71	30	77	17		83	83	30	152	16
	60	72	0	81	17	38	84	84	0	155	8
	61	72	30	85	14		85	84	30	158	0
	62	73	0	89	8		86	85	0	160	15
36	63	73	30	92	22		87	85	30	163	5
	64	74	0	96	10		88	86	0	165	19
	65	74	30	99	21		89	86	30	168	9
	66	75	0	103	5		90	87	0	170	23
	67	75	30	106	11		91	87	30	172	12
	68	76	0	109	16		92	88	0	176	2
	69	76	30	112	20		93	88	30	178	16
	70	77	0	115	22		94	89	0	181	5
	71	77	30	118	22		95	89	30	183	19
	72	78	0	121	22		96	90	0	186	7
37	73	78	30	124	21						

shal knowe what names the elder Greeks did giue them (which names hath been retained euer sith that time) I haue here drawne a like table as your other authors haue set forth, that you may the better conferre the figure with the table, and the more easily vnderstand the one by the other. In which figure the circle A B C D, representeth the horizont, and the right line A C, stādeth

The names and order of the Climates.

B and D in this figure shoulde stand lower against the downe right line.

for the Meridian line. A is the North pole and C the South pole. B the East, and D the West. B D betokening the Equinoctial, and E F the tropike of Cancer, G H the tropike of Capricorne. And all the other lines are the boundes of the Climates eche in his order. The first climate taketh name of Meroe, a famous Iland in Ethiopia vnder Egypt, inclosed by the riuer Nilus. The second Climate is named of Syene, a citie of Egypt, lying directly vnder the tropike of Cancer. The third Climate is called after Alexandria, a notable citie, and an ancient Vniuersitie in Egypt also, lying on the north shore of it. The fourth climate beareth the name of the Rhodes, an Iland better knowne then kept, and yet better lost then kept so deerely. The

fifte

fift climate is expressed by the name of Rome, a citis in Italie well enough known. The 6 Climate is called after ỳ Euxine sea, cõmonly called Ponte. The seuenth climate reacheth from the paralel that passeth by the mouth of the riuer Boristhenes, and extendeth to the paralel that runneth by the south partes of England, as Ptolomy witnesseth in the second booke of his Almagestes. And although more may be said of the climates, yet I wil reserue it to the treatise of Cosmography, and at this time will say no more, but that on the other side of the equinoctiall toward the South, there are the like paralels, and the like climates, with the same quantities of distance from the equinoctial, and the like increase of dayes. The south climates.

Scholler.

The distance of any Climate or Paralel from the equinoctial is equal alwayes with the eleuation of the pole aboue the horizont, as I may easily coniecture: so that when I know the one, I must needes know the other: and that maketh me now to think that if I knowe any eleuation of the pole, I may by this table easily declare howe farre that paralel which serueth for that eleuation, is from the equinoctial circle: and howe long the longest day is in that place. And if it chaunce that the latitude of any region which I doe seeke for, be not in this table iustly expressed, I must then gesse by the proportion of those two numbers, betweene which it standeth, what the precise length of the longest day is. The vse of the table of climates.

Maister.

This table it selfe sufficeth for eche quarter of an houre betweene the longest night of 24 houres, and the longest day of 24. houres: but for more exacter partes of time, I would not wish you to trauel yet, til I may hereafter giue you full rules for it: especially seeing this quarter of the houre is the difference of the whole day, which must be parted into two parts, and the one halfe quarter to be assigned to the difference of the Sun rising, and the other halfe quarter the difference of the sun setting.

Scholler.

That difference is more precise then our clockes or dials doe serue vnto, and therefore I may well enough be satisfied with it for this time: wherefore I pray you now proceed to the Ascensions.

Maister.

The vse of the name of the Ascensions, hath great diuersitie in it, therfore I must by diuision and definition distinct so those diuers varieties, that you may iustly know them eche in his kinde. And first, for the name of Ascension in general, it doth betoken the rising of any stars or signes (whatsoeuer they be) aboue the Horizont. But now are there diuers obseruations of seuerall persons touching the rising of the starres, for Astronomers vse to obserue their rising in forme; that is to say, whether they rise right or obliquely, not

regarding

regarding (in that consideration) the difference in the time of the day: whereas the cunning Marriners, and authours of husbandry, yea and good Phisitions also aswel as Astronomers, do marke their rising at two times principally, that is when they rise iust at the sunne setting, or els iust at the sunne rising.

Scholler.

If Astronomers doe consider only the first forme, then those other formes doe not appertaine to this treatise, which is of Astronomy peculiarly.

Maister.

Although those risings and settings of the starres which Phisitions and other good writers of husbandry and writers also of Nauigation, doe oft times speake of in their writinges, as being such, which in auncient Kalenders haue been set forth plainly for al men to vnderstand, and so might be at this time also, yet he that should wel set them so forth, ought to be skilful in Astronomie, els can he not doe it worthy the reading, and therfore it belongeth to Astronomers to determine their true times. Howbeit, because Poetes haue oftener made mention of such risinges, then Astronomers haue done: therefore both *Ioannes de Sacro Bosco* and others also call them Ascensions Poeticall: not as fained matters, but as thinges often remembred in Poetes bookes. And as I said, they put difference betweene the rising of those starres in the morning with the sunne, and the rising of the same at the sunne setting. The first maner of rising with the sunne, they call in Latine, *Ortus Cosmicus, Mundanus* and *Matutinus*: which may well be named in English the morning rising: the other sorte, which in English ought to be called the Euening rising, is named truely in Latine *Ortus Vespertinus* or *Achronycus*, and not *Temporalis* or *Chronicus*.

Scholler.

Yet many doe call it so, and *Ioannes de Sacro Bosco* sheweth a reason of that name, because (saith he) that Astronomers vse that time after the sunne setting best for marking the course of the starres.

Maister.

Ignorance of the Greeke tongue hath hindered much many good wittes: which may often appeare not only in good *Iohn de Sacro Bosco*: but also in many writers within these 300. yeares especially: but wee must winke at such faultes, which rather were the faultes of the time, then of the persons. And for this name *Achronychus*, is easily turned into *Chronicus*. The first name is often read in Ptolomy and other Greeke writers, and is named of the beginning of the night, which name by ignorance was turned into *Chronicos* in Greeke, and so accordingly was called *Temporalis* in Latine: and then an imagined reason clouted thereto: likewise also in the third kinde of rising and setting, whereof the same authour doth make mention, it appeareth that he was somewhat deceiued, for that ought not to be called properly

rising

riſing of any ſtarre when it getteth out of the Sunne-beames, and may ſhew or ſhine at euening or morning: but it ought rather to be called Apparition or appearing of that ſtarre. And contrariwiſe, when any ſtarre is ſo nigh vnto the ſunne, that the ſunne doth take away or hide the light of it, it ought to be called the Hiding or occultation of that ſtarre, and not the ſetting of that ſtar, ſith ſetting and riſing haue proper relation to the horizont, and yet doth he and many other contrary to the learned Greekes call the firſt, the ſunnely riſing of the ſtarre, and the other, the ſunly ſetting of him. Whereas Ptolomy and the learned Greekes call the one *Phaſis* that is in Latine *Apparitio*, the ſhewing of the ſtarre. And the contrary is called in Greeke *Crypſis* and in Latine *Occultatio*, the darkening or hiding of the ſtarre, which chance happeneth commonly to any ſtarre being within 15. degrees of the ſunne. This paſſion is called of many men *Combuſtion*: Other contract the name of *combuſtion* to ſixe degrees, and call this Oppreſſion. But of all theſe, I will another time declare my full minde, for the iuſt knowledge hereof appertaineth to a higher Arte. And ſo will I hereafter giue you a table declaring the morning and euening riſing and ſetting of al the moſt notable ſtarres, for the matter is not ſo eaſie as it ſeemeth to be.

The third kinde of ſetting.

Combuſtion. Oppreſſion.

Scholler.

I vnderſtand it thus: that when the ſunne is in any part of a Signe, thoſe ſtarres which be in the ſame part of that Signe, doe riſe with the ſunne, and thoſe which be in the like degree of the contrary ſigne, they riſe at the ſunne ſetting.

Maiſter.

Your taking is true for ſuch ſtarres as are nigh vnto the ecliptike line: but yet ſuch ſtarres as be farre from the ecliptike line, may riſe or ſet with the ſunne, although they be in another Signe then the ſunne is, and ſo may they riſe or ſet before or after the ſun, although they be in one degree of any ſigne with the ſunne. And here may you not forget that the ſtarre that ſetteth with the ſunne, is named to haue an euening ſetting: and the ſtarre that ſetteth in the Weſt at the ſunne riſing, is iudged to haue the morning ſetting: whereby it followeth, that the ſtar ỳ hath the morning riſing, hath alſo the euening ſetting; and hee that hath the euening riſing, hath the morning ſetting: Thus haue I ſpoken rudely and lightly for this time, but in the table of theſe riſings and ſettings, you ſhal haue a more exact forme of knowledge ſet out for you, touching this matter. And now to returne to thoſe aſcenſions which be peculiarly called Aſtronomical, firſt for the definition you muſt vnderſtand, that aſcenſion aſtronomicall is the certaine limitation of ſome point of the equinoctial circle, which riſeth iuſtly with any ſtarre, and largely taking the vſe of that name, it betokeneth alſo the arke of the Equinoctial circle, which lieth betweene the beginning of the ſame Equinoctial at

The euening ſetting. Aſcenſion Aſtronomicall.

The morning ſetting.

Aries: and extendeth to the iuſt degree that riſeth with any ſtarre or ſigne. Thirdly the aſcenſion of a ſigne or conſtellation (which includeth a certaine meaſure in length) is that iuſt arke of the equinoctial, which doth paſſe the horizont with that whole ſigne or conſtellation.

Right aſcenſio. Crooked aſcenſion.

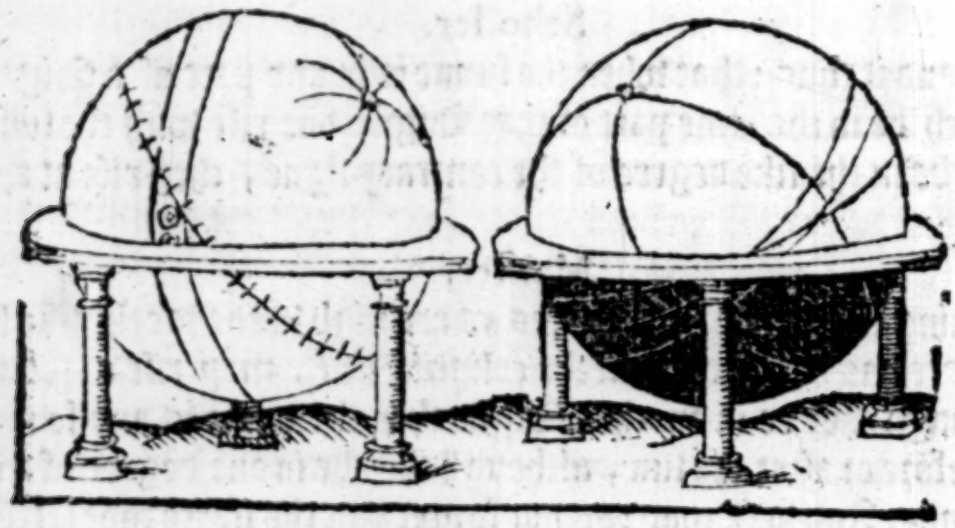
This aſcenſion is cõmonly diuided into 2 kinds, the one is called Right aſcenſion, and the other Oblique or Crooked aſcenſion. Right aſcenſion, is defined to be that, with which a greater portion of the Equinoctial doth aſcend. And that is called Crooked or Oblique aſcenſion, with which a leſſer portion of the Equinoctial doth aſcend.

Scholler.

I heare you ſpeake of a leſſer portion and a greater portion, but where vnto thoſe compariſons ought to be referred, I cannot tell, except I ſhal referre the one to the other.

Maiſter.

That may you not doe, for ſo one aſcenſion might be called right and crooked alſo, at the leaſt in diuers compariſons: but that cannot be, neither is it permitted by any Aſtronomers.



Scholler.

How may it appeare that ſuch abſurditie would follow?

Maiſter.

To the intent that I may alledge nothing, but that which ſhall not onely be certaine and true, but alſo ſhal be manifeſt to you, I will firſt inſtruct you in the vnderſtanding of thoſe aſcenſions, and after that I will returne to the proofe of theſe my wordes. And for the better vnderſtanding of both definitions, I will name vnto you a 3 Aſcenſion, which muſt be as ỳ rule of thoſe other two, and that is the Meane aſcenſion, for ſeeing you cannot well refer greater and leſſer but either to one common meane, or els eche to other: and I haue ſaid before (and will proue it anon) that they cannot be compared to-

either

ther: therefore muſt they be referred and compared to one common meane, which I call the Meane aſcenſion, becauſe that with it there aſcendeth not ſo much of the Equinoctial, as with the right aſcenſion, nor ſo little as doth aſcend with the crooked aſcenſion: And for this cauſe may it well be called a Meane aſcenſion. Again, it may be called a Meane aſcenſion, becauſe it is without all exceſſe: for the portion of the Equinoctiall which aſcendeth with it, is equall to it in preciſeneſſe of degrees, ſo that neither of them exceedeth other. The meane aſcenſion.

Scholler.

It ſeemeth reaſonable that all exceſſes being referred to any one thing, do approoue that one as a meane betweene them: namely when the exceſſes decline to both extremities, as more and fewer, greater and leſſer doe: but in al this kinde of doctrine, the wordes are more eaſie to be vnderſtand, then the matter. Therefore except ye doe with examples declare theſe varieties of aſcenſions, I doubt it will be long before I ſhall wel conceiue them and rightly diſtinct them.

Maiſter.

You haue learned before, that there is two varieties of Spheres, a Righe Sphere, and a Bowing Sphere: and as in eche of theſe the Equinoctial doth keepe one vniforme aſcenſion: that is to ſay, that in 24. houres iuſtly all the Equinoctial doth aſcend: and ſo conſequently in euery houre of the day 15. degrees of the Equinoctiall doe paſſe the right horizont: ſo the Zodiake which is the circle of the ſignes, by meanes of his obliquitie, doth not keepe vniforme aſcenſion any where in any poſition of Sphere. For although the whole Zodiake doe aſcend iuſtly in 24. houres, yet in euery houre, vnequall portions of it doe aſcend, and that diuerſly, according to the diuerſities of the Climates. But in a generalitie of differences, you may take theſe generall rules.

In the right ſphere, euery quarter of the Zodiake hath an equall or meane aſcenſion, with euery quarter of the equinoctiall, beginning the quarters at the 4. principall pointes, which I haue before ſet forth: for if you ſhould take three ſignes in other parts of the zodiake, their aſcenſions wil not agree with a quarter of the Equinoctial, ſith there is no one ſigne that doth equally agree in aſcention with the like portion of the equinoctial: that is to ſay, with 30. degrees in it. Certaine generall rules in a right ſphere.

Scholler.

This rule is in *Ioannes de Sacro boſco*, and in *Orontius* alſo.

Maiſter.

Then you beleeue it the better.

Scholler.

Yea in deed.

Maister.

Then tel me whether the ascension of one of those quarters of the zodiake, ought to be called a Right ascension, or a crooked Ascention.

Scholler.

Neither of both, as I doe vnderstand their definitions, seeing the arke of the equinoctiall that ascendeth with them, is neither greater, neither yet lesser then they, as these definitions doe import, but is equal with them, and therefore it seemeth to me more apt to call it a Meane ascension, after your definition.

Maister.

You say trueth, and therefore is their doctrine imperfect, that make but two ascensions, where three ought to be distinct, (and themselues name three in ble, and but two in distinction and definition) namely seeing (as Tully hath said) it is the greatest fault that can be, to omit any member in diuision: but to omit their faultes in omission, and to returne to their better declaration, this second rule doe they also approoue, yea and natures order doth necessarily inferre the same, that euery two signes or parts of Signes equal in quantitie, and like distant from any one of the 4. principall pointes, haue equal ascensions eche to other.

Scholler.

That is to meane, that Taurus and Aquarius haue equal ascension, because they are equally distant from the equinoctiall point of Aries.

Maister.

And so haue Taurus and Leo, because they differ equally from the Tropicall point of Cancer, and so of al the other. But to the intent that you may the better vnderstand al this that is said, and the rest that is to be saide, I haue heere set forth in a table the iust numbers of degrees of the equinoctiall circle, which doe answere to the degrees of euery Signe in their ascensions in the right sphere. So that if you desire to know the ascension of any degree of any signe, first seeke out the Signe, and then in the first columpne look for the number of the degree, against which in the common corner vnderneath the Signe you may see the number of the degrees and minutes of the Equinoctial, that doe ascend with that degree of the Signe. And those degrees be accompted from the beginning of the equinoctial at Aries, and so orderly after the natural course of the Signes. Whereby you may perceiue, that Aries, Taurus and Gemini all three together haue for their ascension 90 degrees; which number agreeth with the quantitie of three Signes: and therefore is their ascension Meane. And also I may say, that the last degree of Gemini, or any star in that degree, or in the last degree of Virgo, Sagittarius or Pisces, haue a Meane ascension, so that the same star haue no latitude: howbeit in the end of Gemini and Sagittary, although they haue neuer so much latitude,

A Table for the Aſcenſions of the twelue ſignes in the right ſphere.

Degrees of ſignes.	Aries		Taurus		Gemini		Cancer		Leo		Virgo	
	degr	min	degr	min.	degr.	min	degr.	min.	degr.	min	degr.	min.
1	0	55	28	52	58	51	91	5	123	14	153	3
2	1	50	29	49	59	54	92	11	124	16	154	0
3	2	45	30	47	60	57	93	16	125	18	154	57
4	3	40	31	45	62	0	94	22	126	20	155	54
5	4	35	32	43	63	3	95	27	127	21	156	50
6	5	30	33	41	64	7	96	32	128	23	157	47
7	6	26	34	39	65	10	97	37	129	24	158	44
8	7	21	35	38	66	14	98	43	130	25	159	40
9	8	16	36	36	67	18	99	48	131	26	160	36
10	9	11	37	35	68	21	100	53	132	27	161	32
11	10	7	38	34	69	26	101	59	133	28	162	28
12	11	2	39	33	70	30	103	3	134	28	163	24
13	11	57	40	33	71	34	104	8	135	28	164	20
14	12	53	41	32	72	38	105	12	136	28	165	16
15	13	49	42	32	73	43	106	17	137	28	166	11
16	14	44	43	32	74	48	107	22	138	28	167	7
17	15	40	44	32	75	52	108	26	139	27	168	3
18	16	36	45	32	76	57	109	30	140	27	168	58
19	17	32	46	32	78	2	110	34	141	26	169	53
20	18	28	47	33	79	7	111	39	142	25	170	49
21	19	24	48	34	80	12	112	42	143	24	171	44
22	20	20	49	35	81	17	113	46	144	22	172	39
23	21	16	50	36	82	23	114	50	145	21	17	34
24	22	13	51	37	83	28	115	53	146	19	174	30
25	23	10	52	39	84	33	116	57	147	17	175	25
26	24	6	53	40	85	38	118	0	148	15	176	20
27	25	3	54	42	86	44	119	3	49	13	177	15
28	26	0	55	44	87	49	120	6	150	11	178	10
29	26	57	56	46	88	55	121	9	151	8	179	5
30	27	54	57	49	90	0	122	11	152	6	180	0

The second Table of the Ascensions of the twelue signes in the right sphere.

Degrees of signes.	Libra		Scorpius		Sagittar		Capricor		Aquarius		Pisces	
	degr.	min.	degr.	min	degr.	min.	degr.	min	degr.	min.	degr.	min.
1	180	55	208	52	238	51	271	5	303	14	333	3
2	181	50	209	49	239	54	272	11	304	16	334	0
3	182	45	210	47	240	57	273	16	305	18	334	57
4	183	40	211	45	242	0	274	22	306	20	335	54
5	184	35	212	43	243	3	275	27	307	21	336	50
6	185	30	213	41	244	7	276	32	308	23	337	47
7	186	26	214	39	245	10	277	37	309	24	338	44
8	187	21	215	38	246	14	278	43	310	25	339	40
9	188	16	216	36	247	18	279	49	311	26	340	36
10	189	11	217	35	248	21	280	53	312	27	341	32
11	190	7	218	34	249	26	281	58	313	28	342	28
12	191	2	219	33	250	30	283	3	314	28	343	24
13	191	57	220	33	251	34	284	8	315	28	344	20
14	192	53	221	32	252	38	285	12	316	28	345	16
15	193	49	222	32	253	43	286	17	317	28	346	11
16	194	44	223	32	254	48	287	22	317	28	347	7
17	195	40	224	32	255	52	288	26	319	27	348	3
18	196	36	225	32	256	57	289	30	320	27	348	58
19	197	32	226	32	258	2	290	34	321	26	349	53
20	198	28	227	33	259	7	291	39	322	25	350	49
21	199	24	228	34	260	12	292	42	323	24	351	44
22	200	20	229	35	261	17	293	46	324	22	352	39
23	201	16	230	36	262	23	294	50	325	21	353	34
24	202	13	231	37	263	28	295	53	326	19	354	30
25	203	9	232	39	264	33	296	58	327	17	355	25
26	204	6	233	40	265	38	298	0	328	15	356	20
27	205	3	234	42	266	44	299	3	329	13	357	15
28	206	0	235	44	267	49	300	6	330	11	358	10
29	206	57	236	46	268	55	301	9	331	8	359	5
30	207	54	237	49	270	0	302	11	332	6	360	0

titude, yet is their aſcenſion meane. Which prerogatiue thoſe two pointes haue, becauſe the lines or circles of their longitudes do touche both the poles of the zodiake and of the equinoctial, and ſo doth no other circle of longitude: wherefore al ſtarres out of thoſe places limited whereſoeuer they be, they haue no Meane aſcenſion, but either Right aſcenſion, or els crooked.

Scholler.

Thus I perceiue that the two tropike pointes haue a priuiledge aboue the two equinoctial pointes in the aſcenſions.

Maiſter.

It ſeemeth ſo in the right ſphere, but in the Oblique ſphere the equinoctial pointes haue the greater priuiledge: for alwaies in all places where they do aſcend, they keep their meane aſcenſion, but ſo doth not ỳ tropike points in any Oblique ſphere. No neither any ſtarres of their longitude, that is to ſay in their Colure. For although two pointes in the ſkie, where their Colure doth cut the equinoctial circle, haue a meane aſcenſion, yet in thoſe two places is there no ſtarre that hath been noted, as hereafter you ſhal underſtand. But that you may in the meane ſeaſon knowe what ſignes doe aſcend right, and which doe aſcend crookedly in the right ſphere, you ſhall marke this litle table which I haue drawne out of the former great table, where you ſee that foure ſignes agree ſtill in their aſcenſion, and the firſt foure haue but 27. degrees and 54. minutes of the equinoctial anſwering to eche of their aſcenſions: the other 4. ſignes haue 29. degrees, 55. minutes for their aſcenſion: and the laſt 4. haue 32. degrees and 11. minutes agreeing to their riſing, which degrees and minutes adues togither, doe make iuſt 90. degrees, that is exactly one quarter of the equinoctial, and ſo are eche ternary of thoſe ſignes one iuſt quarter of the zodiake.

A briefe table for the right Sphere.

Aſcenſion	The twelue Signes.				Partes of the Equinoctiall		Partes of time	
					Deg.	*Min*	*Hou.*	*Min*
Crooked	Aries	Virgo	Libra	Pisces.	27	54	1	51 3/5
Crooked	Taurus	Leo	Scorpius	Aquarius	29	55	1	59 7/12
Right	Gemini	Cancer	Sagitarius	Capricor.	32	11	2	8 11/12
The addition of thoſe partes eche to his own kind.					90	0	6	0

Scholler.

And in like caſe I perceiue, the 6. houres of time that anſwereth to thoſe whole quarters, is alſo the iuſt quarter of the natural day, which amounteth by

by the addition of the three seuerall times agreeing to those three seuerall ascensions. And as I vnderstand it, the quantitie of time is gathered after the rate of 15. degrees ascending euery houre, as you said before: so that euerie degree asketh 4. minutes of an houre: and 15 minutes of a degree in the equinoctial doe rise in one minute of an houre: for this is alwaies to be remembred, that a minute is euermore the 60 part of ỳ thing whereunto it is referred. But nowe there commeth to my minde the saying of *Ioannes de sacro Bosco*, which long hath troubled my minde, and I cannot learne of anie man how to vnderstand him well: for in mine opinion his wordes import an impossibilitie. He blameth this argument as euil. These two arkes are equall, and they begin to rise togither, and continually there riseth a greater portion of the one arke then of the other: *Ergo*, that arke will bee full risen soonest, whose greater portion did alwaies rise. This argument seemeth inuincible in mine opinion, and yet I*ohn de sacro bosco* for improouing of it alledgeth an example, whereby as he seemeth to intend, the antecedent may be true, and and the consequent false: and therefore the argument must needes bee naught.

Maister.

Repeat you his example, that we may examine it.

Scholler.

Hee willeth to take any quarter of the zodiake, compared with his like quarter of the equinoctiall, and to beginne with that quarter from the first point of Aries, to the latter ende of Gemini, alwayes the greater portion riseth of the zodiake, and the lesser of the equinoctiall, and yet those two quarters ascend fully together: and the like must you vnderstande of the thirde quarter, from the beginning of Libra to the end of Sagittarie: but contrariwise in the quarter that lieth from the first part of Cancer, to the last of Virgo, the portion of the equinoctiall in rising, is still greater then the part of the zodiak that riseth with it: and yet those both arkes do rise iustly together at the end.

Maister.

Here is a great fallacion by amphibologie, as Logitians do call it, so that in one sence it may be true, and in another it is false. And first for declaration of Iohn his meaning (as I thinke) marke as many parts of those two first quarters as you list, and still by the former table, as well as by turning the sphere it selfe, it will appeare manifestly, that the portion of the zodiake is euer greater then the match portion of the equinoctiall.

Scholler.

That is most true: for with 12 degrees of Aries there ascendeth of the equinoctiall 11 degrees and two minutes onely of the equinoctiall, that is 58 minutes lesse; with 30 degrees of Aries there ariseth but 27 degrees

and

and 54 minutes, which is leſſe by two degrees and fiue minutes: alſo in Taurus, 15 degrees hath for their aſcenſion 42 degrees and 32 minutes, that is two degrees and 28 minutes too litle: the laſt of Taurus aſcendeth with 57 degrees and 49 minutes, which ſhould be 60 if it were equall with the degrees of the zodiake. Again, the 16 degree of Gemini anſwereth to the aſcenſion of the 74 degree and 48 minute of the equinoctiall, which in equalitie would be 76: and the 29 degree of Gemini ſhould haue by order of equalitie the 89 degree of the equinoctiall, and hath but 88 degrees and 55 minutes: which is leſſer by fiue minutes then equalitie requireth, and ſo doth it appeare in all the reſt, ſaue in the very laſt degree of Gemini, where both numbers appeare euen.

Maiſter.

Then are the words of *Iohn de ſacroboſco* true.

Scholler.

This matter troubleth me too much: for of this am I aſſured, that if any two quantities be equall together, and a leſſer portion of the firſt matches with a greater part of the ſecond, then of neceſſitie that part that remaineth of the firſt quantitie, muſt needes be greater then that that reſteth of the ſecond.

Maiſter.

That is true alſo: for if you abate vnequal partes from two equal quantities, the portions that remaine will be vnequal, and that part will be leaſt, from which the greater portion was abated.

Scholler.

As that cannot be falſe, ſo it ſeemeth to me, that ſeeing there doth aſcend with the whole ſigne of Aries but 27 degrees, and 54 minutes, there muſt needes remaine 62. degrees and 6 minutes of that quarter, and that is more then the 60 degrees which reſteth of the like quarter of the zodiake. Nowe thoſe 62. degrees and 6 minutes will aſcend with the 60 degrees of the zodiake, ſo that then there doth not ſtill aſcend a leſſer portion of the equinoctial: for as the firſt portion was leſſer, ſo this ſecond part is greater.

Maiſter.

Your coniecture is good: and to approoue it the better, you may conferre ſome leſſer partes of thoſe two quarters together, as from the 20 degree of Taurus, to the 10. degree of Gemini, the degrees betweene them are 20. and to knowe the arke of the Equinoctial that aſcendeth with thoſe 20. degrees, ſubſtract the leſſer from the greater, and the aſcenſion of thoſe 20. degrees will remaine.

Scholler.

The aſcenſion of the 20. degree of Taurus is 47. degrees and 33. minutes; the aſcenſion of the 10. degree of Gemini is 68 degrees, and 21 minutes.

Deg.	Min.
68	21
47	33
20	48

nutes. Wherefore setting those numbers in conuenient order, and making subtraction duely, there resteth 20 degrees and 48 minutes: so is this portion of the equinoctial the greater by 48. minutes.

Maister.

Proove againe from the 28 degree of Taurus, to the 28 degree of Gemini: which difference is 30 degrees.

Scholler.

With the 28 degree of Taurus there doth ascend 55 degrees, and 44. minutes: and with the 28 of Gemini, 87, and 49. and by Subtraction the difference appeareth to be 32 degrees, and 5 minutes.

So is the arke of that Equinoctial greater by two degrees and fiue minutes, then the matche arke of the zodiake. And therefore are not *Iohn de sacro bosco* his wordes true.

87.	49
55.	44
32	5

Maister.

Proove yet more before you condemne him. Try the arke from the 10. degree of Taurus, to the 22. degree of the same signe, which arke includeth 12. degrees of the zodiake.

Scholler.

The 10 degree of Taurus, ascendeth with 37 degrees and 35 minutes of the equinoctial: the 22 degree of the same signe hath for his ascension 49. degrees and 35 minutes, the difference between them by subtraction is found to be 12 degrees iust: and so that arke of the Equinoctial is equall with his matche arke in the zodiake.

49	35
37	35
12	0

Maister.

Yet once more proove the arke from the last degree of Aries to the second degree of Gemini, which arke is 32 degrees.

Scholler.

The last degree of Aries riseth with 27 degrees, and 54 minutes: and the 2. of Gemini hath 59 degrees and 54 minutes in his ascension. Betweene which two numbers, the distance is 32 degrees exactly, and so are those two arkes equall also, and neither of those two examples doe make the arke of the equinoctial lesser then the matche arke in the zodiake: so that they make against *Iohn de sacro bosco*.

59	54
27	54
32.	0

Maister.

Indeede as his wordes be placed in the present time, they cannot be true, but his meaning may be more fauourably gathered, by turning the Present time into the Perfect time, and referring the name of ascension to the whole ark that is fully risen in that quarter, as I did in the explication of his words occasion:

occaſion you to make proofe: wherefore take any part of the firſt quarter, and accompt from the beginning of Aries: or likewiſe any part of the third quarter, and reckon from the beginning of Libra, and ſo ſhal you ſee alwaies that the portion of the zodiake which is aſcended, ſhalbe greater then the part of theequinoctial that is riſen with it: and ſo ſhal it continue euen to the very laſt degree of them both, and then at length do both the quarters end their aſcenſions exactly together.

Scholler.

As you ſay. Now do I perceiue it, ſo that the fault is rather in his words then in his meaning.

Maiſter.

Such meane matters muſt be winked at in other, but not followed. And now for the order of aſcenſion of the other two quarters which begin at Cancer and Capricorne, you ſhal vnderſtand the like: but that the greater portion that aſcendeth is referred to the equinoctial circle, and not to the zodiake.

Scholler.

So I vnderſtand by this former table that with the 28 degree of Cancer there aſcendeth 120 degrees and 6 minutes of the equinoctial, which is two degrees and 6 minutes more then equalitie would yeeld: and with the 26. degree of Virgo, there riſeth the 176 and 20 minutes of the equinoctial, which is alſo more then equalneſſe by 20 minutes: & ſo if I take any degree of any ſigne in that ſecond quarter, or in the 4 quarter, beginning at Capricorne, I may lightly ſee by the table that the portion of the Equinoctiall in in his aſcention is greater then the match arke of the zodiake from the beginning of Aries to that degree: whereby it appeareth that al thoſe 6 ſignes do aſcend right, becauſe a greater portion of the equinoctial aſcendeth with them.

Maiſter.

Then by the like reaſon, the other 6 ſignes Aries, Taurus, Gemini, Libra, Scorpius and Sagittarius doe aſcend crookedly, becauſe the leſſer portion of the equinoctiall doth aſcend with them: after that ſort of conference, which is contrary to that I ſaid before, that 4 ſignes only doe aſcend right in the right ſphere: Wherefore you muſt vnderſtand, that for to know the aſcention of euery ſigne, you muſt conſider that ſigne alone, and the arke of the equinoctiall that doth aſcend with it, and ſo ſhall you ſee exactly the aſcention of euery ſigne ſeuerally. And here you ſhall vnderſtand, that al aſtronomers commonly doe call the Right aſcention ſo largely, that it extendeth to the aſcention of all the Signes in a Right ſphere: and ſo they name the Oblique aſcention the riſing of all the Signes in any Oblique ſphere, whereby it appeareth that they giue the name of Right and Crooked aſcentions, according to the horizonts or poſitions of the Sphere, and not after the quan-

Another ſignification of right aſcenſion

A Table of Ascension of the signes in 52. degrees of latitude.

Degrees of signes.	Aries		Taurus		Gemini		Cancer		Leo		Virgo	
	degr.	min.	degr.	min.	degr.	min.	degr.	min.	degr.	min.	degr.	min.
0	0	0	12	48	29	42	56	11	94	6	137	0
1	0	24	13	16	30	24	57	17	95	30	138	37
2	0	48	13	45	31	7	58	24	96	54	139	54
3	1	12	14	14	31	50	59	31	98	18	141	20
4	1	37	14	42	32	34	60	39	99	42	142	47
5	2	2	15	12	33	18	61	48	101	7	144	12
6	2	26	15	42	34	3	62	58	102	32	145	40
7	2	51	16	13	34	49	64	9	103	57	147	6
8	3	15	16	42	35	36	65	20	105	22	148	32
9	3	40	17	14	36	24	66	32	106	47	149	58
10	4	5	17	45	37	12	67	45	108	12	151	24
11	4	30	18	16	38	1	68	59	109	28	152	50
12	4	55	18	48	38	51	70	13	111	4	154	16
13	5	20	19	20	39	42	71	28	112	30	155	42
14	5	45	19	52	40	34	72	44	113	56	157	8
15	6	10	20	25	41	26	74	0	115	23	158	39
16	6	35	20	59	42	19	75	17	116	49	160	0
17	7	1	21	34	43	13	76	34	118	15	161	26
18	7	26	22	8	44	8	77	52	119	42	162	52
19	7	52	22	43	45	3	79	11	121	8	164	18
20	8	18	23	18	45	59	80	30	122	35	165	43
21	8	44	23	54	46	56	81	50	124	2	167	9
22	9	11	24	31	47	54	83	10	125	28	168	35
23	9	37	25	8	48	53	84	31	126	55	170	1
24	10	4	25	45	49	53	85	51	128	22	171	27
25	10	31	26	23	50	54	87	12	129	48	172	52
26	10	58	27	2	51	56	88	34	131	15	174	18
27	11	25	27	41	52	59	89	57	132	41	175	44
28	11	53	28	21	54	2	91	20	134	8	177	9
29	12	20	29	1	55	6	92	43	135	34	178	35
30	12	48	29	42	56	11	94	6	137	0	180	0

Degrees of signes.	Libra		Scorpius		sagittari		apricor		Aquarius		Piſces	
	deg	min	deg	min	deg.	min	deg.	min	deg	min	deg	min
0	181	0	223	0	265	54	303	49	330	18	347	12
1	181	25	224	26	267	17	304	54	320	50	247	40
2	182	51	225	52	268	40	305	58	[illegible]			
3	184	16	227	19	270	3	307	1	334	29	349	25
4	185	42	228	45	271	26	308	4	332	58	349	2
5	187	8	230	12	272	48	309	6	333	27	250	29
6	188	33	231	38	274	9	310	7	334	15	350	56
7	189	59	233	5	275	29	311	7	334	52	350	23
8	191	25	234	32	276	50	312	6	335	29	350	49
9	192	51	235	58	278	10	312	4	336	6	351	16
10	194	17	237	25	279	30	313	1	336	43	351	44
11	195	44	238	52	280	49	313	57	337	17	352	8
12	197	8	240	18	282	8	314	52	337	52	352	34
13	198	34	241	45	283	20	316	47	338	26	352	50
14	200	0	243	11	284	43	317	41	339	1	353	25
15	201	26	244	37	285	9	318	34	339	35	353	50
16	202	52	246	4	287	16	319	26	340	8	354	15
17	204	18	247	30	288	32	320	18	340	40	354	40
18	205	44	248	56	289	47	321	9	341	12	355	5
19	207	10	250	22	291	1	321	59	341	[illegible]	355	[illegible]
20	208	35	251	48	292	15	322	48	342	15	355	55
21	210	2	253	13	293	28	323	36	342	46	356	20
22	211	28	254	38	294	40	324	24	343	17	356	45
23	212	54	256	3	295	51	325	11	343	47	357	9
24	214	20	257	28	297	2	325	57	344	18	357	34
25	215	47	258	52	298	12	326	42	344	4	357	58
26	217	13	260	18	299	21	327	26	345	17	358	23
27	218	40	261	42	300	29	328	10	345	46	358	47
28	220	6	263	6	301	36	328	53	346	15	359	12
29	221	33	264	30	302	42	329	36	346	44	359	36
30	223	0	265	54	303	49	330	18	347	12	360	0

tities of time in their ascension. And this shall suffise at this time touching ascensions in the Right Sphere: in which also the descensions or settinges vnder the Horizont, are equal with the Ascensions, so that they need not to haue any peculiar declaration: but in the Oblique Spheres it is not so, but contrariwise, those signes that doe ascend right, doe descend crooked: and they that ascend crooked, do descend right: so that the descention of any signe in an Oblique sphere, is equall precisely to the ascension of the contrary sign.

Of the descension of signes.

Scholler.

You meane that the descending of Aries is equall to the ascending of Libra, and the descending of Taurus is one in quantitie of time with the ascension of Scorpius.

Maister.

So it is indeede. And in this great varietie you shall marke one constant vniformitie, that the ascension and descention of any signe in any crooked sphere ioyned by addition togither, doe make an equall summe of time with the ascension and descension of the same signe in a right sphere, in like sorte ioyned togither: but to the intent that you may vnderstand all these thinges the better, and also know the iust Ascension of euery signe in this our climat where the elevation of the pole is 52. degrees, I haue drawne here a special table for that latitude. In which you shall vse the like manner of entering, as you did in the other, so that although the numbers differ, yet the worke differeth: not in this table the first columne containeth the degrees of the Signes, and the other columnes doe containe the degrees and minutes of the equinoctial vnder eche signe, accordingly as they doe answere to the Ascension of the degrees of the same signes. By this table you may see a great diuersitie in the ascensions from those in the right sphere: And yet this may you certainly obserue: that euery two Signes being contrary togither, the one lying against the other, as they haue farre vnlike ascensions: so yet if you adde their both ascensions togither, they will be equall to the ascensions of the same two signes in the Right sphere.

Scholler.

Then in as much as the ascension of Aries is in this latitude 12. degrees and 48 minutes, and the ascention of Libra, 43. degrees iust (abating as I ought 180 degrees) and so they both by additiō do make 55. degrees, & 48. minutes. And in the right sphere eche of these signes hath for his ascention 27. degrees and 54 minutes (for the contrary signes there are equall in their ascension) wherefore by addition there will amount the same summe precisely that was gathered before: and so likewise of Taurus and Scorpius: their ascentions ioyned togither maketh 59 degrees and 48 minutes: but in the right sphere, those two ascentions maketh 59, 50, that is two minutes

12	48
43	0
55	48

27	54
27	54
55	48

nutes onely difference in two signes, so is it but one minute in one signe, that is not to be regarded.

Maister.

Not greatly, and especially in an Introduction. But do you marke here the Signes that ascend right, and them that ascend crooked?

Scholler.

Although I see a difference by this Table from the other: I had thought that the more crooked sphere had made the more crooked ascention onelie: but yet that they alwayes had kept one name in generall, and not haue changed it: but by your question onely I am admonished of mine errour: for I see that Libra (as it is easily viewed) doth ascend here right, and hath for his ascention 43 degrees, and in the right sphere it did ascend crookedly, and had but 27 degrees and 54 minutes for his ascention, and therefore may I doubt of all the rest, till I haue examined their ascentions better.

Maister.

To ease you of paine, lo here is a table of their iust ascentions, which you may examine at leasure.

A briefe Table for 52 degrees of latitude.

Ascension	The 12 Signes.		Parts of the Equin.		Parts of time.	
			degrees.	minutes.	houres	minutes
Crooked	Aries,	Pisces,	12	48	0	51 $\frac{3}{15}$
Crooked	Taurus,	Aquarius,	16	54	1	7 $\frac{9}{15}$
Crooked	Gemini	Capricornus,	26	29	1	45 $\frac{14}{15}$
Right	Cancer,	Sagittarius,	7	55	2	31 $\frac{10}{15}$
Right	Leo,	Scorpius,	42	54	2	51 $\frac{2}{15}$
Right	Virgo,	Libra,	43	0	2	52
The addition of those parts			180	0	12	0

By this table you may perceiue what Signes do rise crookedly, and which do ascend right, and that there be of ech sort 6: so that from Cancer to Capricorne all the Signes in direct order do ascend right, and from Capricorne to Cancer, in naturall order of the Signes, all those 6 Signes doe rise crookedly. And this rule is generall in all these north climates, that lie from 30 degrees of latitude (vnder which Memphis and Alcaire are, and mount Sinai: also the Isle of Madera, and the part of the west Indies called *Terra Florida*) vnto 66 degrees and a halfe of latitude, in that climate where Island lieth, and the north partes of Norway, and namely Halgoland, where Ohthere dwelt, that was the first discouerer of the north voyage towardes Moscouia.

Scholl. That voyage I desire much to vnderstand, and so do many other.

Maister.

Another time shall serue for it, for now we haue another matter in hand.

Scholler.

Then for this present matter: Is there any other varietie of ascension betweene the equinoctiall circle and the latitude of 30 degrees?

Ma. Yea, much diuersitie: for (as you haue heard) vnder the equinoctiall 8. signes do ascend crookedly, and but 4 right: but from the equinoctiall vnto 10 degrees of latitude, 6 signes ascende right, (Gemini, Cancer, Leo, Scorpius, Sagittarius, Capricornus) and other sixe crooked, that is, Aries, Taurus, Virgo, Libra, Aquarius and Pisces. And from 10 degrees vnto 30 there are 8 signes that rise right, as Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, and Capricornus: and the other foure, Aries, Taurus, Aquarius and Pisces, rise crookedly: but to the intent that you may haue the better abilitie to iudge of such varieties, I haue here set foorth diuers tables for examples sake: and namely such, which import any varietie of alteration, or helpe to the apt vnderstanding of the same.

A Table for the latitude of 1. degree.

Ascension	The 12 Signes.	Parts of the Equin. degrees	Parts of the Equin. minutes	Parts of time. houres	Parts of time. minutes
Crooked	[illegible]	27	12	1	50 $\frac{12}{15}$
Crooked	[illegible]	29	48	1	58 $\frac{12}{15}$
Right	Gemini, Capricornus,	32	8	2	8 $\frac{8}{15}$
Right	Cancer, Sagittarius,	32	16	2	9 $\frac{1}{15}$
Right	Leo, Scorpius	30	4	2	0 $\frac{4}{15}$
Crooked	[illegible]	28	6	1	52 $\frac{6}{15}$
The summe of those parts		180	0	12	0

A Table for 10. degrees of latitude.

Ascension	The 12 Signes.	Parts of the Equin. degrees.	Parts of the Equin. minutes.	Partes of time. houres	Partes of time. minutes.
Crooked	Aries, Pisces,	25	51	1	42 $\frac{6}{15}$
Crooked	Taurus, Aquarius,	28	14	1	52 $\frac{14}{15}$
Right	Gemini, Capricornus,	31	31	2	6 $\frac{1}{15}$
Right	Cancer, Sagittarius,	32	53	2	11 $\frac{8}{15}$
Right	Leo, Scorpius,	31	34	2	6 $\frac{4}{15}$
Crooked	Virgo, Libra	29	57	1	59 $\frac{12}{15}$
The summe of those partes		180	0	12	0

A Table for 11. degrees of latitude.

Ascention	The 12 Signes.	Parts of the Equin.		Partes of time.	
		degrees.	minutes.	houres	minutes.
Crooked	Aries, Pisces,	25	38	1	42 8/15
Crooked	Taurus, Aquarius,	28	4	1	52 4/15
Right	Gemini, Capricornus,	21	27	2	5 12/15
Right	Cancer, Sagittarius.	32	57	2	11 12/15
Right	Leo, Scorpius,	31	44	2	6 14/15
Right	Virgo, Libra,	30	10	2	0 10/15
The summe of those partes		180	0	12	0

A Table for 20. degrees of latitude.

Ascention	The 12 Signes.	Parts of the Equin		Parts of time	
		degrees	minutes	hours	minutes
Crooked	Aries, Pisces,	23	26	1	32 9/15
Crooked	Taurus, Aquarius,	25	27	1	45 12/15
Right	Gemini, Capricornus,	30	43	2	3 3/15
Right	Cancer, Sagittarius,	33	36	2	14 6/15
Right	Leo, Scorpius,	32	21	2	13 6/15
Right	Virgo, Libra	32	0	2	8 0
The summe of the parts		180	0	12	0

A Table for 29. degrees of latitude.

Ascention	The 12 Signes.	Parts of the Equin.		Parts of time.	
		degrees.	minutes.	houres	minutes
Crooked	Aries, Pisces	21	25	1	25 10/15
Crooked	Taurus, Aquarius,	24	37	1	38 13/15
Right	Gemini Capricornus,	30	1	2	0 1/15
Right	Cancer, Sagittarius,	24	22	2	17 8/15
Right	Leo, Scorpius,	25	11	2	20 11/15
Right	Virgo, Libra,	34	23	2	17 8/15
The summe of the parts		180	0	12	0

A Table for 30. degrees of latitude.

Ascention	The 12. Signes.	Parts of the Equin.		Partes of time.	
		degrees.	minutes	houres.	minutes
Crooked	Aries, Pisces,	21	9	1	24 9/15
Crooked	Taurus, Aquarius,	24	23	1	37 8/15
Crooked	Gemini Capricornus,	29	56	1	59 14/15
Right	Cancer, Sagittarius,	34	28	2	17 13/15
Right	Leo, Scorpius,	35	25	2	21 15/15
Right	Virgo, Libra	34	39	2	18 9/15
The summe of the partes		180	0	12	0

A Table for 50. degrees of latitude.

Ascention	The 12. Signes	Parts of the Equin.		Partes of time.	
		degrees.	minutes	houres.	minutes
Crooked	Aries, Pisces,	12	52	0	55 7/15
Crooked	Taurus, Aquarius,	17	55	1	11 19/20
Crooked	Gemini, Capricornus,	27	0	1	48
Right	Cancer, Sagittarius,	37	24	2	29 9/15
Right	Leo, Scorpius,	41	53	2	47 8/15
Right	Virgo, Libra	41	56	2	47 11/15
The summe of the partes		180	0	12	0

A Table for 60. degrees of latitude.

Ascention	The 12 Signes.	Parts of the Equin.		Parts of time.	
		degrees.	minutes.	houres	minutes
Crooked	Aries, Pisces	7	16	0	20 1/2
Crooked	Taurus, Aquarius,	10	56	0	43 1/2
Crooked	Gemini Capricornus	22	56	1	31 11/12
Right	Cancer, Sagittarius	41	28	2	45 11/12
Right	Leo, Scorpius	48	52	3	15 7/12
Right	Virgo, Libra.	48	32	3	14 1/2
The summe of the parts		180	0	12	0

A Table for 66. degrees and ½ of latitude.

Ascention	The 12 Signes	Parts of the Equin.		Parts of time.	
		degrees	minutes.	houres	minutes
Sodaine	Aries, Pisces,	0	0	0	0
Sodaine	Taurus, Aquarius,	0	0	0	0
Sodaine	Gemini, Capricornus,	0	0	0	0
Right	Cancer, Sagittarius,	64	22	4	17 7/12
Right	Leo, Scorpius,	59	49	3	59 4/12
Right	Virgo, Libra	55	49	3	42 4/12
The summe of the parts		180	0	12	0

Scholl. Sir, I thanke you most heartily for these Tables, for I haue not seene the like of them before: and their order is so easie, that I neede no great helpe in the vnderstanding of them: For as in the title of eache of them is set the degree of the latitude of the region for which the table is calculate, so in the first columne is sette the differences of the Ascensions in name, and in the second columne are the names of the Signes, which haue those diuerse

Ascen-

Aſcentions, ech rowe containing two Signes, whereby they differ from the right Sphere, for in it 4 ſignes agree in one quantity of aſcention, where as in all theſe Oblique ſpheres, onely two ſignes do agree in likeneſſe of aſcention. And in ech of them are there ſet in the third columne, the degrees of aſcention, and minutes after them, which appertaine to euery ſigne: and in the fourth columne are the parts of time, agreeing to thoſe parts of the equinoctiall circle: by which it may appeare not only how many degrees and minutes thoſe Signes occupy in their aſcention, but alſo how many houres or minutes doe anſwere to the ſame. And in ech table is ſet the full quantitie of halfe a day, and alſo of halfe the zodiake, which is the full ſumme by addition of all the other parcels ouer them: whereby I perceiue it to be true, that eche halfe of the equinoctiall doth equally aſcend with ech halfe of the zodiake.

The firſt rule of Oblique aſcention.

Maiſter.

Beginning the halues of them both at the equinoctiall points, in Aries and Libra, it is moſt true: but not ſo if you begin at the tropike points, or in any other parts of them: for if you beginne at any of the Northerly Signes betweene Aries and Libra, and ſo recken 6 ſignes together, thoſe ſignes ſhal haue a right aſcention: for with them ſhall aſcend a greater portion of the equinoctiall. But if you doe recken ſixe Signes and beginne that account betweene Libra and Aries, in the South part of the zodiake, then doe thoſe ſixe Signes aſcend crookedly: foraſmuch as the portion of the equinoctiall that riſeth with them, is leſſe then halfe of it.

Scholler.

For proofe thereof I take the table of ten degrees of latitude, and I beginne with Taurus, and ſo do I recken ſixe Signes, Taurus, Gemini, Cancer, Leo, Virgo and Libra, vnto which Signes theſe ſixe numbers anſwere as they be here ſet, accounting one number twice, that is firſt for Virgo, and then for Libra, and ſo the whole ſumme of parts of the equinoctiall is 184 degrees and 6 minutes: that is 4 degrees and 6 minutes more then halfe: wherefore thoſe Signes doe aſcend right. And ſo I perceiue it will be in the other like works, if I doe begin with any Signe in that North halfe of the zodiake, for ſeeing Aries hath the leaſt of al other aſcentions, if I take any other Signe, and omit him, I ſhall haue a greater number then the halfe of the equinoctiall circle. But now contrariwiſe if I beginne with any of the South Signes, and ſo recken ſixe continuall Signes, their aſcention you ſay will be an Oblique aſcention, becauſe their degrees will be more in number then the degrees of the equinoctiall circle: for example I take my beginning at Sagittarius, and ſo recken fourth directly ſixe Signes, that is Sagittarius, Capricornus, Aquarius, Piſces, Aries and Taurus; and for them

Degrees	*Minutes.*
28	14
31	31
32	53
31	34
29	57
29	57
184	6

them I take the numbers of their ascensions, and set them downe as here you see: so that by addition they do make 172 degrees, and 34 minutes: that is lesse then the halfe circle by 7 degrees, and 26 minutes. Wherefore it must needs be, that those signes doe ascend crookedly.

Degrees.	Minutes.
32	53
31	31
28	14
25	51
25	51
28	14
172	34

Maister.

And so must it follow where soeuer you begin after Libya in that South halfe of the zodiake: for so much as you omit the ascension of Libya, being 29 degrees and 57 minutes, and in steed of it you take the ascension of Aries, which is but 25. degrees and 51. minutes.

Scholler.

This reason doth appeare manifest inough: and that not only in this table, but also in all the other, saue that in the last table I see a strange disagreement from all the other. For in these six signes, Aries, Taurus, Gemini, Capricornus, Aquarius and Pisces, there is set no numbers of degrees or minutes for their ascension, but only ciphers, which thing is strange to me: for thereby may it be coniectured, that those 6. Signes haue none Ascension at all: and yet I am sure that the first 3. of them do ascend not only in ỳ climate, but also in all other Climates by north that latitude euen to the north Pole.

Maister.

A little mistaking doth disturbe your minde much, but if you doe place the sphere in the Horizont, in such sorte, that the North pole be 66. degrees and a halfe aboue the horizont, and then turne the first degree of Aries, to the East Horizont ready to ascend, and afterward if you turne the Globe toward the West, but by the quantitie of halfe one degree in the equinoctial, you shall perceiue that all those 6 Signes which lie from the Winter Tropik vnto the Summer Tropike, that is to say, Capricornus, Aquarius, Pisces, Aries, Taurus, and Gemini, will ascend sodainly in one moment all 6 at once: so that for their ascention there cannot be assigned no degree of the equinoctial, neither any sensible part of time, such it is done in a moment of time, and therfore must I put no degree for their ascention; neither yet anie time. And because I thought no lesse but that this would seeme something strange vnto you, therefore haue I not touched anie thing of the other Ascensions for these Climates that bee betweene the Tropike of Cancer and the Pole, being assured that they woulde seeme to you much more strraunge, then this doth. But hereafter if I perceiue that you trauell well in this first Introduction. I will instruct you more largely in all that shall bee needefull for you: and in that meane season I will prosecute the rules of these ascensions in the Oblique Spheres, as I did beginne. Wherefore you shall note, that although eche halfe of the zodiake doe agree in ascention

sention with eche halfe of the Equinoctial: yet the partes of those halues, I meane the seueral signes, and their distinct portions doe not so agree, but are either more or lesse.

Scholler.

So I remember doth *Iohn de sacro bosco* affirme: for (saith he) in that half of the zodiake, which is betweene the beginning of Aries, and the end of Virgo, alwaies the portion of the zodiake which riseth, is greater then the like halfe of the Equinoctial: and yet those halues doe rise togither. Iohn de Sacro Bosco his rules examined.

Maister.

This he speaketh of the Oblique sphere.

Scholler.

So doth he indeed.

Maister.

Propound you an example, that I may know how you doe vnderstand it.

Scholler.

I take an example out of the table of 50 degrees of latitude, and for the first fiue Signes I set the quantities of their ascensions as here is seene, which by addition doe make 138. degrees and foure minutes. So doth there want of 150 degrees. which are the full degrees for fiue signes, 11 degrees and 56 minutes. That arke therefore of the equinoctial is lesser then the match arke of the zodiake: but now there resteth in that halfe of the equinoctial 41 degrees & 56 minutes, which is the iust ascention of Virgo, in that latitude. And so those both halues doe ascend iointly togither.

13	52
17	55
27	0
37	24
41	53
138	14

Maister.

Proove the like worke in the table of 10 degrees of latitude.

Scholler.

For the first 5. signes Aries, Taurus, Gemini, Cancer and Leo, I set their ascensions thus. And by addition I find that their whole sum for al that arkes ascension is 150 degrees and three minutes, that is three minutes more then the degrees of fiue signes, which is 5 times 30. And so is this example against the rule, for here the greater portion is of the equinoctial.

25	51
28	14
31	31
32	53
21	24
150	3

Maister.

Proue yet againe in the table of one degree of latitude.

Scholler.

The ascensions of the first 5 Signes in that latitude, are these: and make in one total sum, 151 degrees, and 54. minutes: that is one degree, and 54 minutes more then the like arke of the 5. signes in the zodiake, which containeth but only 150 degrees. And so is this example also against the rule.

27	42
29	44
32	8
31	16
20	4
151	54

Maister.

So you haue two examples contrary to that rule.

Scholler.

It cannot be denied.

Maister.

Then is that no certaine rule.

Scholler.

It seemeth so.

Maister.

Indeede it is true only aboue 13 degrees of latitude. For in all climates and paralels vnder 13 degrees of latitude, the equinoctial maketh greatest number of degrees in his arke. So that Iohn *de sacro bosco* his woordes may not be accompted true generally) as they sound) but particularly betweene 13 degrees of latitude, and 66 and an halfe: and so is it to be said of diuers other of his rules.

Scholler.

Is there the like diuersitie beyond 66. degrees and a halfe northward?

Maister.

There is more diuersitie, but such and so strange as I will not at this time trouble your head withal, but wil appoint a more conuenient place for it.

Scholler.

Then I beseech you to prosecute the rest of Iohn *de sacro bosco* his rules, touching ascentions.

Maister.

Repeate you the rules.

Scholler.

His next rule is: that in the other halfe of the zodiake, from the beginning of Libra, to the end of Pisces, euermore there riseth a greater part of the Equinoctial then of the zodiake, and yet both those halues doe rise fully together.

Maister.

Proone it by some examples.

Scholler.

In the latitude of 30 degrees I take Libra only, and finde against it 34. degrees and 39 minutes so is there 4 degrees and 39. minutes more of the Equinoctiall of the zodiake agreeable to the rule. Also in the table of 60 degrees with Libra, there doth ascend in the equinoctiall 48. degrees and 32 minutes. That is to say 18 degrees and 32 minutes more then the 30. degrees of Libra.

Maister.

Assay the like in the latitudes of one degree, and of 10. degrees.

Scholler.

Scholler.

In the latitude of 10 degrees, the ſigne of Libra hath for his aſcenſion 29 degrees, and 57 minutes of the equinoctiall, that is three minutes leſſe then the degrees of the zodiake, and ſo is that contrary to the ſaid rule.

Maiſter.

Now proue the other.

Scholler.

In that paralel where the Pole is but one degree high, the Signe of Libra aſcendeth with 28 degrees and 6 minutes of the equinoctial, ſo is that arke of the equinoctial leſſer then the degrees of the ſaid ſigne of Libra, by 1. degree and 65 minutes, and yet by the rule it ſhould be greater. Wherefore I may perceiue, that this rule doth not ſerue for all latitudes, but for certaine of them. And as I thinke, not for any aboue 10 degrees, although (as you ſaid) the other exception did extend to 13 degrees of Latitude.

Maiſter.

What cauſeth you to thinke ſo?

Scholler.

The table calculate by you for 11 degrees of latitude, where I ſee 30. degrees, and 10 minutes of the equinoctial, aſſigned for the aſcention of the equinoctial, aſſigned for the aſcenſion of the portion of the equinoctial greater by 10 minutes then the portion of the Zodiake.

Maiſter.

Indeed for whole ſignes this exception extendeth not aboue 10 degrees of latitude, and no more doth the other former exception, but yet in partes of Signes it extendeth in them both to 13 degrees, as hereafter you ſhall perceiue more at large. But now go forth to the next rule.

Scholler.

The 4. rule is this: that thoſe arkes which ſucceed after Aries vnto the end of Virgo in the oblique ſphere, doe abate their aſcenſions in compariſon to the aſcenſions that they haue in the Right ſphere: namely ſeeing leſſe doth riſe of the equinoctial. The 4. rule.

Maiſter.

For trial of this rule I haue ſet forth here a table containing all the diuerſities (though not all the ſeuerall degrees of latitude) that happen in any climate vnder 67 degrees of latitude, that is vnto the polare circle. So that by this table you may examine all the rules both of *Ioannes de Sacro boſco*, and alſo of others. Now therefore examine thoſe arkes that follow Aries, and ſo abate their aſcenſions, as your rule ſaith, from Aries vnto the end of Virgo.

Scholler.

Firſt for Aries it ſelfe: I ſee that it abateth in this table from 27. degrees

and

and 54. minutes vnto nothing. And Taurus abateth also from 29. degrees and 54. minutes vnto nothing. Likewise Gemini abateth from 32. degrees and 12. minutes vnto nothing. But contrariwise, Cancer, Leo, and Virgo,

A Table of Ascensions, shewing all diuersities of them, vnto the Polare circle, peculiar for euery seuerall Signe.

Degrees of latitude.	Aries / Pisces		Taurus / Aquarius		Gemini / Capricor		Cancer / Sagittari.		Leo / Scorpius		Virgo / Libra	
	deg.	min.	deg.	min.	deg.	min.	deg.	min.	deg.	min.	deg.	min.
0	27	54	29	54	32	12	32	12	29	54	27	54
1	27	42	29	44	32	8	32	16	30	4	28	6
2	27	30	29	34	32	4	32	20	30	14	28	18
3	27	17	29	25	32	0	32	24	30	23	28	31
5	26	53	29	4	31	52	32	32	30	44	28	55
8	26	16	28	34	31	40	32	44	31	14	29	32
10	25	51	28	14	31	31	32	53	31	34	29	21
11	25	38	28	4	31	27	32	57	31	44	30	10
15	24	46	27	23	31	10	33	14	32	25	31	2
20	23	39	26	27	30	48	33	36	32	21	32	9
25	22	27	25	27	30	24	34	0	31	21	33	21
30	21	9	24	23	29	56	34	28	35	25	34	39
35	19	43	23	9	29	24	35	0	35	39	36	5
40	18	4	21	45	28	47	35	37	38	3	37	44
45	16	10	20	3	28	1	36	23	39	45	39	38
50	13	52	17	55	27	9	37	24	41	53	41	56
55	11	1	15	5	25	31	38	53	44	43	44	47
60	7	16	10	56	22	56	41	28	48	52	48	32
65	2	4	3	44	15	20	49	2	56	5	53	45
66½	0	0	0	0	0	0	64	22	59	49	55	49

do not abate, but increase the quantities of their Ascensions: so that in the three first signes only (that is Aries, Taurus and Gemini) that rule is true, and in the other three Signes, Cancer, Leo, and Virgo, it appeareth vtterly to be false.

Maister.

Wee

Yet in one manner of conſideration thoſe woꝛdes may be true as hee hath ſpoken them, though not ſo largely as the woꝛdes do ſound: foꝛ it appeareth that your authour accounteth the beginning of thoſe arkes (whereof he ſpeaketh) not from diuers and ſeuerall points, but from one common beginning, which is the firſt degree of Aries, and in that ſence his rule is true: foꝛ pꝛooſe whereof here be two other tables ſet foꝛth, in which is declared the quantities of the aſcentions of the twelue Signes, but not in ſuch ſoꝛt as it was in the table next befoꝛe, foꝛ there euery arke of the ſeuerall Signes did take his beginning at the firſt degree of the ſame Signe: but in theſe 2. tables the arke of aſcention is accounted from the firſt degree of Aries, as from the common beginning, and endeth at the laſt degree of euery ſeuerall Signe. And now by this firſt table, if you examine the foꝛmer rule, you ſhal finde it to be true.

A Table for the diuerſities of Aſcenſions for the firſt ſixe Signes from the Equinoctiall to the Polare circle, accounting the beginning of euery arke, from the firſt degree of Aries.

The elevation of the Pole	Aries		Taurus		Gemini		Cancer		Leo		Virgo	
	degr.	min.	degr.	min.	degr.	min.	degr.	min.	degr.	min.	degr.	min.
0	27	54	57	48	90	0	122	12	152	6	180	0
1	27	42	57	26	89	24	121	50	151	50	180	0
2	27	30	57	4	89	8	121	28	151	42	180	0
3	27	17	56	42	88	42	121	6	151	29	180	0
4	27	5	56	20	88	15	120	44	151	17	180	0
5	26	53	55	57	87	49	120	21	151	5	180	0
8	26	16	54	50	86	30	119	14	150	28	180	0
10	25	51	54	5	85	36	118	29	150	3	180	0
11	25	38	53	42	85	9	118	6	149	50	180	0
15	24	46	52	9	83	19	116	33	148	58	180	0
20	23	39	50	6	80	54	114	30	147	51	180	0
25	22	27	47	54	78	18	112	18	146	39	180	0
30	21	9	45	32	75	28	109	56	145	21	180	0
35	19	43	42	52	72	16	107	16	143	55	180	0
40	18	4	39	49	68	36	104	13	142	16	180	0
45	16	10	36	13	64	14	100	37	140	22	180	0
50	13	52	31	47	58	47	96	11	138	4	180	0
55	11	1	26	6	51	37	90	30	135	13	180	0
60	7	16	18	12	41	8	82	36	131	28	180	0
65	2	4	5	48	21	8	70	10	126	15	180	0
66 1/2	0	0	0	0	0	0	64	22	124	11	180	0

A Table for the diuersities of Ascensions for the fixe southerly Signes accounting the beginning of those Ascensions, from Aries first degree.

Degrees of latitude.	Libra		Scorpius		Sagittar		Capricor		Aquarius		Pisces	
	degr	min	degr	min	degr	min	degr.	min	degr	min	degr	min.
0	207	54	237	48	270	0	302	12	332	6	360	0
1	208	6	238	10	270	25	302	34	332	18	360	0
2	208	18	238	32	270	52	302	56	332	30	360	0
3	208	31	238	54	271	16	303	18	332	43	360	0
4	208	42	239	16	271	45	303	40	332	55	360	0
5	208	55	239	39	272	11	304	2	333	7	360	0
8	209	22	240	46	273	20	305	10	333	44	360	0
10	209	57	241	31	274	24	305	55	334	9	360	0
11	210	10	241	54	274	51	306	18	334	22	360	0
15	211	2	243	27	276	41	307	51	335	14	360	0
20	212	0	245	20	279	6	309	54	336	21	360	0
25	213	21	247	42	281	42	312	6	337	33	360	0
30	214	29	250	4	284	32	314	28	338	51	360	0
35	216	5	252	44	287	44	317	8	340	17	360	0
40	217	44	255	47	291	24	320	11	341	56	360	0
45	219	28	259	23	295	46	323	47	343	50	360	0
50	221	56	263	49	301	12	328	13	346	8	360	0
55	224	47	269	20	308	23	333	54	348	59	360	0
60	228	22	277	24	318	52	341	48	352	44	360	0
65	233	45	289	50	338	52	354	12	357	56	360	0
66½	235	48	295	36	360	0	0	0	0	0	0	0

Scholler.

I perceiue that the first line of numbers vnder the signes, against the cipher 0, doth represent the quantities of the ascentions in the right sphere, and all the other lines doe declare the speciall quantities of seuerall ascentions in ech of those distinct latitudes, which be noted in the first columne in both tables. Therefore now I may perceiue according to the former rule, that the greatest number of any downe right columne is the highest number in the head of the same columne, so that it may truely be said (as appeareth in this first table) that in ech oblique sphere the ascentions of the arkes from Aries vnto the end of Virgo, do abate still and ware lesse and lesse, in respect to their ascentions that they haue in the right sphere.

Maister.

Maiſter.

Thus you ſee, howe there may accounted diuers formes of aſcentions: firſt (as I ſayde at the beginning of that definition) it may ſignify that degree certeinely of the equinoctiall, which doth aſcend with any ſigne or part thereof: as for example, in the latitude of 50 degrees, the laſt degree of Aries hath for his aſcention the 13 degree and 52 minute of the equinoctiall, as by the firſt of theſe two tables it doeth appeare: and in the ſame table it appeareth, that the laſt degree of Taurus hath for his aſcention in the ſame latitude the 31 degree & 47 minute of the equinoctial. And in the ſecond ſignification, the aſcention of Aries whole ſign is that whole arke of 13 degrees and 52 minutes, and ſo the whole arke from the beginning of Aries, to the end of Taurus, hath for his aſcention that whole arke of 31 degrees and 47 minutes of the equinoctial. And in this ſignification doth *Iohn de Sacro Boſco* vſe the name of Aſcention, and in this ſence his rules be true: according to which ſence I haue drawen to you certaine tables: the firſt for the aſcentions of the twelue Signes in the right Sphere: the ſecond, for the aſcention of the Signes in 52 degrees of latitude: the third and fourth are theſe two tables laſt before, which for diuers latitudes doe declare the quantities of the aſcentions of all arkes of whole Signes accounted from the beginning of Aries. The third ſignification of the aſcentions is the quantitie of that arke of the equinoctiall which aſcendeth with any certaine arke of the zodiake: as for example, that arke of the equinoctiall that aſcendeth with any Signe ſeuerally taken, is called the aſcention of that Signe. So haue you for euery Signe certaine ſeueral arkes of aſcention aſſigned, & ſet forth here in diuers tables, according to diuers eleuations of the Pole. And in this ſignification muſt it be vnderſtoode, when it is ſayd that any Signe hath a Right aſcention or an Oblique aſcention, for if the arke of the equinoctiall that riſeth with that Signe, be greater then 30 degrees, then hath that Signe a Right aſcention: and if the arke of the equinoctiall be leſſer then 30 degrees, then is that aſcention called an Oblique aſcention: but if the ſayd arke of the equinoctiall be iuſt 30 degrees, then is it a Meane or Equall aſcention.

Three ſignifications of aſcenſion.

A Right aſcention.

An Oblique aſcention.

A meane aſcention.

Scholler.

Now doe I better vnderſtande the vſe of theſe names then I did before: and alſo I perceiue howe the names of greater and leſſer portion are to be referred, not of eche greater to eche leſſer, for ſo the aſcention of Taurus might bee accounted greater then the aſcention of Aries, and leſſer then the aſcention of Gemini, in all climates without the Polare circle. And ſo one aſcention might be both greater and leſſer, and therefore both right and crooked, which is an abſurditie.

Maiſter.

Thus hath order taught you, that wherof you were in doubt, & manifeſtly

approoued that that seemed very obscure, Nowe therefore returne to your authour againe: And repeate his other rules as he doth teache them.

Scholler.

The 1st rule. His 1st rule is this: The arkes which follow Libra, vnto the end of Pisces, in an Oblique sphere, doe increase their ascensions aboue the ascentions that they haue in the Right sphere in as much as the portion of the Equinoctiall is augmented. And the increase of those ascensions is agreeable in rate to the decreale of those other ascensions which succeed from Aries to Libra.

Maister.

This rule must bee vnderstand of ascentions in the second signification: and that may you try by the latter of those two Tables which I gaue you last.

Scholler.

It appeareth so indeed: for Libra increaseth from 207 degrees and 54. minutes, vnto 235 degrees and 48. minutes. And Scorpio from 237 degrees and 48. minutes, vnto 295. degrees and 36 minutes. Likewise Sagittarius from 270 degrees vnto 360 degrees. So doth it appeare, that Libra doth increase betweene the equinoctial and the Polare circle, 27 degrees, and 54 minutes. And Scorpio increaseth 57 degrees and 50. minutes. Also Sagittarius augmenteth by 90 degrees. And nowe contrariwise, Aries doth abate from 27 degrees and 54. minutes to nothing. Taurus diminisheth from 57 degrees and 48 minutes vnto nothing also. And Gemini abateth from 90. to 0: so doth these three in decreale agree with the other in increase exactly.

Maister.

The 1st rule. And so may you iudge of the other three couples. And therefore saith your authour, that hereby it is manifest, that two equall arkes lying one against the other, and in an Oblique sphere, haue their ascentions ioyntly taken together equall with the ascensions of the same arkes in a Right Sphere, ioyntly taken also: for although those arkes be vnequall together, yet as much as the one abateth on the one side, so much the other increaseth on the other side; and so both arkes in the right sphere are equall to both those arks in any Oblique sphere.

Scholler.

But I pray you, in what signification of ascention is that rule to be vnderstand.

Maister.

In any of these two which bee referred to arkes: for the first can haue no place here, because it signifieth the ascension of one point only, and not of any arke as the other two doe, and as this rule doth import.

Scholler.

Then may I proove by examples in both sortes of tables. And first to begin

gin with thoſe tables that accompt the whole arkes from the beginning of Aries, I finde the aſcenſion of Aries in the head of the Table, that is in the right ſphere, to be 27 degrees and 54 minutes, and the aſcenſion of Libra (which is againſt it) 207 degrees and 54 minutes. Which both ioyned togither, make 235 degrees and 48 minutes. Now to prooue the like in an Oblique ſphere, I take the latitude of 40 degrees, and there I find for Aries his aſcenſion 18 degrees and 4 minutes: and for Libra I finde in the ſecond table 217 degrees and 44 minutes: which both being added togither, doe make 235 degrees and 48 minutes. That is preciſely equall with the former aſcenſions in the right ſphere. Alſo in the eleuation of 60 degrees I trie the like, where Aries hath 7 degrees and 16 minutes, and Libra hath 228 degrees and 32 minutes, which by addition amount to the ſame ſumme as before.

27	54
207	54
235	48
18	4
217	44
235	48
7	16
228	32
235	48

Maiſter.

Attempt the like in the other tables.

Scholler.

I take the arke of Aries aſcenſion as before 27 degrees and 54 minutes: and the aſcenſion of Libra (accompting only the arke of it from his own beginning) in like ſort 27 degrees and 54 minutes. So that both ioyned togither, make 55 degrees and 48 minutes. Then in the latitude of 55 degrees, I finde for Aries 11 degrees and one minute; and for Libra, 44 degrees and 47 minutes. And by addition I finde that they make the ſame number as before.

27	54
27	54
55	48
11	1
44	47
55	48

Maiſter.

Make proofe in ſome other arke.

Scholler.

I take firſt the arke from the beginning of Leo, to the end of the ſame ſigne, and finde it to be 29 degrees and 54 minutes in the right ſphere: and ſo for the Aſcenſion of the Signe Aquarius, being equall to it, and againſt it in the zodiake, I finde the like number, which make by addition 59. degrees and 48 minutes. Then in the latitude of 30 degrees I try the like, and finde for Leo 35 degrees, and 25 minutes: and for Aquarius there doth riſe 24 degrees and 23 minutes: which make alſo togither the ſame ſumme of 59 degrees and 48 minutes. So in both thoſe ſignifications, whether I accompt ſeuerall arkes from ſeuerall beginninges, or generall arkes from one generall beginning, the rule is found true. Nowe reſteth but one rule more of aſcenſions in this authour to be diſcuſſed, and that is this: that in an oblique ſphere eche two arkes of the zodiake being equal and equally diſtant from any one of the Equinoctiall pointes, ſhal haue equal aſcenſions.

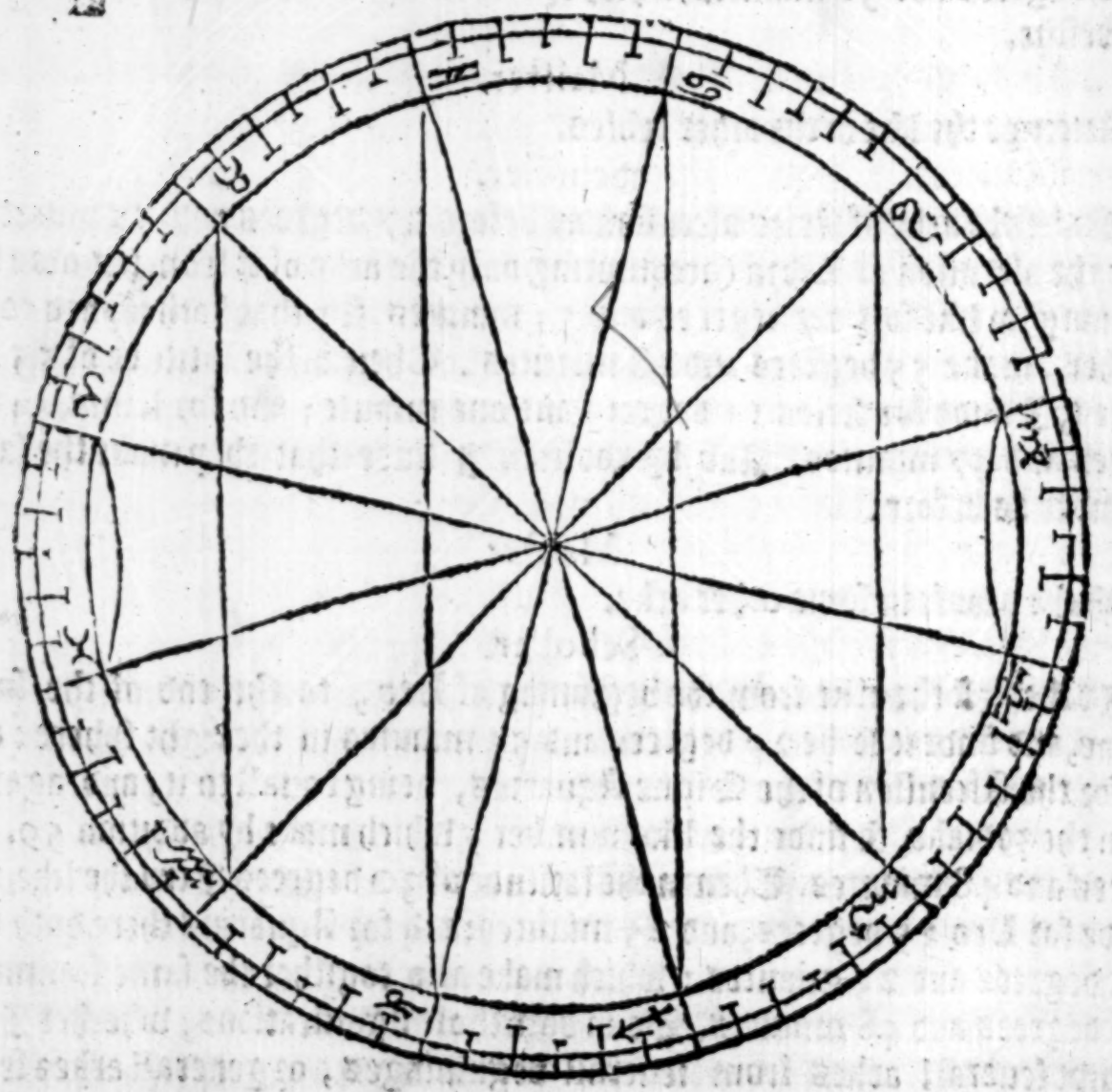
29	54
29	54
59	48
35	25
24	23
59	48

The 7. rule.

Maiſter.

This rule is partly agreeable with the laſt rule, and partly ſeuerall, in as

much as euery contrary arke is like diſtant from the one Equinoctial point, as the firſt arke is from the other equinoctial point. This rule doth agree (after a ſorte though not properly) with the other laſt before: but conſidering that Aries and Piſces as whole ſignes haue like arkes, and are equally diſtant from one Equinoctial point, though in backe order: for the end of Aries is iuſt equall in diſtance from the preciſe equinoctial point, as the beginning of Piſces is from the ſame. And in this point theſe Signes haue this 7. rule as a ſpeciall rule for them and their aſcenſions. Likewiſe Taurus compared with Aquarius, Gemini with Capricorne, Cancer with Sagittarius, Leo with Scorpius, and Virgo with Libra, as this figure doth ſhew exactly, although in the ſame I haue marked alſo the contrary ſignes that it might



be a common figure for both thoſe rules, ſo that euery ſeuerall ſigne hath 2 matches, with which it may be conferred, one of them right againſt him. And that compariſon is in the 6 rule: and the other leſſe diſtant, and their conference belongeth to this ſeuenth rule.

Scholler.

As this figure doth teach me what ſigns may be conferred together, ſo the tables

tables before written doe declare the quantities of their aſcenſions in thoſe ſeuerall latitudes: and the true meaning of both thoſe rules, as well as of o-ther, touching aſcenſions.

Maiſter.

But this muſt you further know, that thoſe rules doe ſpeake generally of any two arkes, whether they be greater or leſſer then a ſigne, and do not mean of ſignes onely.

Scholler.

That muſt needs follow orderly: for if Aries be equall in aſcenſion with Piſces, and Taurus equall in riſing with Aquarius, then ioyntly Aries and Taurus muſt needs be of one quantitie in aſcenſion with Aquarius and Piſces, by compoſition of proportions, as is taught in Geometry and Arithmetike alſo.

Maiſter.

Likewiſe (by reſolution of proportions) if al Aries be like in aſcention with al Piſces, then the firſt degree of Aries ſhall aſcend equally with the laſt degree of Piſces: and the 20 degree of Aries, with the 10 degree of Piſces: and in like maner of eche other degree equally diſtant from the equinoctiall pointes; and ſo likewiſe of euery minute: for theſe rules of equalitie or inequalitie of aſcenſions of arkes, doe ſerue alwel for the arks of degrees & minutes, as for the arkes of whole ſignes, or of greater quantities. Alſo this rule is generall, that al arkes that aſcend rightly, doe deſcend crookedly, be they great or ſmall: and contrariwiſe, what arke ſoeuer aſcendeth crookedly, doth deſcend right; whereby it commeth to paſſe, that alwaies the one ſigne counteruailing with his contrary, there is euermore one halfe of the zodiake aboue the horizont, alwell as there is one halfe of the equinoctial aboue the ſame. So that whenſoeuer any degree of the zodiake doth ſet in the Weſt, the contrary degree doth riſe in the Eaſt. Of this it followeth, that in the longeſt day in the yeare there doth riſe but 6 Signes, & in the ſhorteſt day there riſeth as many Signes.

Scholler.

Therefor it may ſeeme to come to paſſe, that in auncient time the day and the night were euermore diuided into 12 equall partes (howe long or howe ſhort ſoeuer they were) & thoſe partes were called Vnequal houres, of which yet many men doe write, and doe call them houres of the Planetes: but as I iudge by the order of the aſcenſions, euery Signe hath not equall aſcenſion, nor equall time in riſing, and therefore may thoſe houres be wel called Vnequall, which depend of the motion of the zodiake, being in it ſelfe vnequall in his aſcenſion. Houres vnequall.

Maiſter.

It is thought of ſome men to be a more apt reaſon to call thoſe houres vnequall, becauſe not onely the Summer houres are vnequall to the Winter

houres,

houres, but also the day houres vnequall to the night houres.

Scholler.

Naturall houres. *Iohn de Sacro Bosco* doth call them naturall houres, and defineth them to be the measure of the time, in which halfe a signe doth ascend.

Maister.

As the 6. signes that rise in the day or in the night keep not one vniforme equalitie in their rising, so doth the Ascensions of the half signes differ more vnequally: and by that meanes the houres of the day cannot be equall togither, neither yet the houres of the night may be called equall togither: wherfore either you must not allow that definition, or els you must not part the day and the night into equall partes.

Scholler.

I knowe not what to say to this, for neither can I defend that definition, neither yet can I improoue that partition.

Maister.

Equal houres called equinoctial houres. Those houres haue been the occasion of much contention, and therefore were they wittily reiected out of the dayly vse, wherein they were once common, and were left only to learned men, for learned vses, and in their steede other houres more certaine and equall were deuised, which doe diuide the naturall day into 24 equall partes, and these keepe one iust quantitie, howsoeuer the artificiall day doe vary his quantitie.

Scholler.

This I know well: but yet touching the first houres, called the Planet houres, I woulde gladly vnderstand some example for their exact diuersitie in some one day.

Maister.

You shall haue anone one generall table for many daies, namely for euery first day in the peare nigh hand, and that table shall suffice for the whole yere: and it shall be calculate according to that exact forme of distinction of houres, by halfe Signes of the zodiake: but in the meane season, because you shall not be ignorant of the vulgar forme of vnequall houres, I haue here set forth an orderly partition of them, according to the length of euery day or night in the peare, by increase from 12 minutes to 12 minutes, for eche day or night, from the shortest day, or night of 1. minute of length, vnto the longest day or night of 24 houres.

Scholler.

But what if the longest day be not so long, as it is not with vs in England?

Maister.

The table doth serue for all places where the daies be of shorter length: as by the ouermost title and that first columne on the left hand you may perceiue.

Scholler.

Scholler.

I was too negligent that I did not conſider that, for as it may ſerue for that day in the peare which is but 16 houres long, (though the longeſt day be longer) ſo may it ſerue for that place where the longeſt day is but 16. houres in quantitie.

A table for the houres of Planets after the common forme.

Minutes.	0		12	24		36		48	
Houres	hour.	minut	hour.	minut	hour.	minut	hour.	minut	hour.	minut
0	0	0	0	1	0	2	0	3	0	4
1	0	5	0	6	0	7	0	8	0	9
2	0	10	0	11	0	12	0	13	0	14
3	0	15	0	16	0	17	0	18	0	19
4	0	20	0	21	0	22	0	23	0	24
5	0	25	0	26	0	27	0	28	0	29
6	0	30	0	31	0	32	0	33	0	34
7	0	35	0	36	0	37	0	38	0	39
8	0	40	0	41	0	42	0	43	0	44
9	0	45	0	46	0	47	0	48	0	49
10	0	50	0	51	0	52	0	53	0	54
11	0	55	0	56	0	57	0	58	0	59
12	1	0	1	1	1	2	1	3	1	4
13	1	5	1	6	1	7	1	8	1	9
14	1	10	1	11	1	12	1	13	1	14
15	1	15	1	16	1	17	1	18	1	19
16	1	20	1	21	1	22	1	23	1	24
17	1	25	1	26	1	27	1	28	1	29
18	1	30	1	31	1	32	1	33	1	34
19	1	35	1	36	1	37	1	38	1	39
20	1	40	1	41	1	42	1	43	1	44
21	1	45	1	46	1	47	1	48	1	49
22	1	50	1	51	1	52	1	53	1	54
23	1	55	1	56	1	57	1	58	1	59
24	2	0								

Maiſter.

Yea and for the middle of the earth vnder the Equinoctiall, where the

longest day is but 12. houres, so that it serueth from the equinoctial circle, vnto the Polare circle, and for al climates that be betweene them, as by the houres in the first columne you may perceiue. So that if you will know the quantitie of anie houre vnequall, or houre of the Planets, after this forme: first you must know the iust quantitie of the day artificial, from sun rising to sun setting, and thereby also the quantitie of the night: then shall you seek the houres of their length in the first columne, vnder the title of houres: and if the day or night haue any minutes aboue those euen houres, you shal seeke them in the highest range of numbers, where they be set from 12 to 12, and take that number of minutes that is next in quantitie to your minutes in the day propounded: and in the common angle, against your houres and vnder your minutes, you shal finde the iust quantitie of the minutes that make an houre vnequal, for that day or night: but that must you vnderstand seuerally.

The vse of the table.

Scholler.

I were too grosse headed if I would make a doubt thereof. And because I will declare vnto you how I vnderstand the vse of it, I will by an example or two make it appeare. When the artificiall day is 14. houres long, and 20. minutes, and the night then is 9. houres long and 40 minutes of necessitie: I would know the iust quantitie of the houres vnequall. First therefore, in the first columne I seeke out the numbers of the houres, which is 14: then in the highest raunge of numbers I seeke the odde minutes, being 20, and because I find no such number there, I take the next number which is 24, & by those 2 numbers in their common angle against 14 toward the right hand, directly vnder the 24 minutes, I finde 1,12. Whereby I vnderstand, that eche vnequall houre is longer then the equall houre by 12 minutes that day. And for the night I finde against 9, and vnder the number of 36 (which is next vnto 40) the iust quantitie of eche vnequall houre of the same night, to be 0,48, that is but 48 minutes: and so is the vnequall houre of the night lesser by twelue minutes, then is the equal houre. And so both those houres ioyned together, doe make two houres, equall to two equinoctial or equall houres, For so much as the one is too little, the other is too great. Againe for another trial, I take the artificiall day to be 8 houres and 36. minutes long, and therefore to knowe the quantitie of an vnequal houre, I seeke against 8, and vnderneath 36, where I find 0,43, which giueth me to vnderstand that the vnequall houre that day is only 43 minutes in quantitie, and the night then being 15 houres long and 24 minutes, yeeldeth his vnequall houres of 1 houre and 17 minutes long: whereby it is seene also, that so much is supplied by the one houre as was wanting in the other. So that euermore one vnequal houre of the day ioyned with an vnequall houre of the night, wil make two houres equall to two equinoctiall houres.

Scholler.

You

You meane those common houres which we vse vulgarly, which are called also of some men Natural houres, taking that name of the Natural day, which they diuide into 24 equal partes, (though other men ascribe that name to vnequal houres) and so of their common vse are they named Vulgare, like as they are called Equinoctial houres, because (as I haue learned) they depend of the reuolution of the equinoctial: and therefore keepe they one constant quantitie, eche being equall with other.

Houres equal, equinoctial, vulgar and natural.

Maister.

You remember it well. And as these are taken of the motion of the Equinoctial, and are nothing els but the space or measure of time wherein 15 degrees of the Equinoctial doe passe the meridiane line: so againe it seemeth to the wisest sorte of men, that the Vnequal houres ought to be gathered by the motion of the zodiake, whose seuerall forme of ascension for euery half signe, doth make a seuerall and distinct quantitie of Vnequal houres, and haue no fewer sorts of differēces, then there be distinct and seuerall degrees or points, at which that arke of 15 degrees may begin his ascension, as partly in this table following it doth appeare: where you may see in the first columne on the left hand, and in the last on the right hand, the degrees of the signes set: not euery one seuerally, but only from fiue degrees to 6 degrees, which are so many as may seeme to suffice for a conuenient distinction of the seuerall diuersities in such houres, namely in that latitude of 52 degrees, for which it is calculate. And nert vnto those degrees in the second columne, and in the last saue one, are set the names of the 12 Signes in their conuenient order, that is to say, in the one part the 6 Signes which be called north Signes, as Aries, Taurus, Gemini, Cancer, Leo, and Virgo: and in the other are set the 6 South signes, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, and Pisces. And against those signes and degrees are set the quantities of euerie houre in the day for that time, when the sunne is in any such degree of those signes. And for the better knowledge of the houres, their names & numbers are set forth in the head of the table: where also is set a distinction by diuersitie of the day and night accordingly as the sun is then in the south Signes or in the north signes.

Vnequall houres.

The declaration of the table.

Scholler.

I do perceiue it to be reasonable, that the first houre of the day must be accompted that houre, in whose beginning the sun doth rise: so that euery day the first houre is begun with the ascension of that degree of any signe wherein the sunne is. And the first houre of the night is begunne with the ascension of that degree, which is opposite or contrary to the place of the sunne; which place is commonly called in Latine *Nadir solis*, although indeed the one worde is an Arabike worde, and not Latine. And after that first houre as the other houres of necessitie doe followe in order of number; so their distinction in quantitie doth follow in this table: and the difference of them is agree-

The fourth Treatise of

A Table for the distinction of the vnequall houres,

Houres of the day, for the north signes: and of the night for the south signes.

Signes		1 7		2 8		3 9		4 10		5 11		6 12	
Hours		1	2	3	4	5	6	7	8	9	10	11	12
		H.M	H.M	H.M	H.M	H.M	H M	H M	H.M	H M	H.M	H M	H.M
0	♈	0 25	0 27	0 30	0 37	0 47	0 59	1 11	1 20	1 25	1 26	1 27	1 25
6		0 25	0 28	0 33	0 41	0 52	1 4	1 16	1 23	1 26	1 27	1 26	1 26
12		0 26	0 30	0 36	0 45	0 57	1 9	1 19	1 24	1 26	1 26	1 26	1 26
18		0 27	0 32	0 39	0 49	1 2	1 13	1 22	1 26	1 27	1 26	1 26	1 26
24		0 29	0 34	0 45	0 54	1 7	1 17	1 24	1 26	1 26	1 26	1 26	1 26
30	♉	0 30	0 37	0 47	0 59	1 11	1 20	1 25	1 26	1 27	1 25	1 26	1 26
6		0 33	0 41	0 52	1 4	1 16	1 23	1 26	1 27	1 26	1 26	1 26	1 26
12		0 36	0 45	0 57	1 9	1 19	1 24	1 26	1 26	1 26	1 26	1 26	1 27
18		0 39	0 49	1 2	1 13	1 22	1 26	1 27	1 26	1 26	1 26	1 26	1 26
24		0 43	0 54	1 7	1 17	1 24	1 26	1 26	1 26	1 26	1 26	1 27	1 26
0	♊	0 47	0 59	1 11	1 20	1 25	1 26	1 27	1 25	1 26	1 26	1 26	1 25
6		0 52	1 4	1 16	1 23	1 26	1 27	1 26	1 26	1 26	1 26	1 26	1 24
12		0 57	1 9	1 19	1 24	1 26	1 26	1 26	1 26	1 26	1 27	1 25	1 22
18		1 2	1 13	1 22	1 26	1 27	1 26	1 26	1 26	1 26	1 26	1 24	1 19
24		1 7	1 17	1 24	1 26	1 26	1 2	1 26	1 26	1 27	1 26	1 27	1 15
30	♋	1 11	1 20	1 25	1 26	1 27	1 25	1 26	1 26	1 26	1 25	1 21	1 11
6		1 16	1 23	1 26	1 27	1 26	1 26	1 26	1 26	1 26	1 24	1 17	1 7
12		1 19	1 24	1 26	1 26	1 26	1 25	1 26	1 27	1 26	1 22	1 13	1 2
18		1 22	1 26	1 27	1 26	1 26	1 26	1 26	1 26	1 24	1 19	1 9	0 57
24		1 24	1 26	1 26	1 26	1 26	1 26	1 27	1 26	1 27	1 15	1 4	0 52
0	♌	1 25	1 26	1 27	1 25	1 26	1 26	1 26	1 25	1 21	1 11	0 59	0 47
6		1 26	1 27	1 26	1 26	1 26	1 26	1 26	1 24	1 17	1 7	0 54	0 47
12		1 26	1 26	1 26	1 26	1 26	1 27	1 26	1 22	1 13	1 2	0 49	0 39
18		1 27	1 26	1 26	1 26	1 26	1 26	1 22	1 19	1 9	0 57	0 45	0 26
24		1 26	1 26	1 26	1 26	1 27	1 26	1 27	1 15	1 4	0 52	0 41	0 35
0	♍	1 25	1 26	1 26	1 26	1 26	1 25	1 21	1 11	0 59	0 47	0 37	0 30
6		1 26	1 26	1 26	1 26	1 26	1 24	1 17	1 7	0 54	0 47	0 34	0 33
12		1 26	1 26	1 26	1 27	1 26	1 22	1 12	1 2	0 49	0 39	0 32	0 27
18	♎	1 26	1 26	1 26	1 26	1 24	1 19	1 9	0 57	0 45	0 36	0 34	0 26
24		1 26	1 26	1 27	1 26	1 27	1 15	1 4	0 52	0 41	0 33	0 28	0 25
30		1 26	1 26	1 25	1 25	1 21	1 11	1 59	0 47	0 37	0 30	0 27	0 25
		M.M	H.M	H.M	H.M	H.M	H M	H.M	H.M	H.M	H.M	H.M	H M

calculate for the latitude of 52. degrees.

Houres of the night for the north Signes: and of the day for the ſouth Signes.

7 1	8 2	9 3	10 4	11 5	12 6	Signes
1 | 2	3 | 4	5 | 6	7 | 8	9 | 10	11 | 12	Houres
I M H.M	H.M H.M	H.M H M	H.M H.M	H M H.M	H.M H.M	
1 26 1 26	1 26 1 25	1 21 1 11	0 59 0 47	0 37 0 30	0 27 0 25	♎ 0
1 26 1 26	1 26 1 24	1 17 1 7	0 51 0 47	0 34 0 32	0 26 0 24	6
1 26 1 27	1 26 1 22	1 13 1 2	0 49 0 39	0 32 0 27	0 25 0 25	12
1 26 1 26	1 24 1 10	1 0 0 57	0 45 0 36	0 34 0 26	0 25 0 25	18
1 27 1 26	1 27 1 15	1 1 0 52	0 41 0 33	0 28 0 25	0 24 0 26	4
1 26 1 25	1 21 1 11	0 59 0 47	0 37 0 30	0 27 0 25	0 25 0 27	♏ 0
1 26 1 24	1 17 1 7	0 54 0 47	0 34 0 33	0 26 0 24	0 25 0 28	5
1 26 1 22	1 13 1 2	0 56 0 39	0 32 0 27	0 25 0 25	0 26 0 30	12
1 24 1 19	1 9 0 57	0 45 0 3	0 34 0 26	0 25 0 25	0 27 0 32	18
1 27 1 15	1 1 0 52	0 41 0 33	0 28 0 25	0 24 0 26	0 29 0 34	24
1 21 1 11	0 59 0 47	0 37 0 30	0 27 0 25	0 25 0 27	0 30 0 37	♐ 0
1 17 1 7	0 54 0 47	0 34 0 33	0 26 0 24	0 25 0 28	0 32 0 41	6
1 13 1 2	0 49 0 39	0 32 0 27	0 25 0 25	0 26 0 30	0 36 0 45	12
1 9 0 57	0 45 0 36	0 34 0 26	0 25 0 25	0 27 0 32	0 39 0 49	18
1 4 0 52	0 [illegible] 0 33	0 28 0 25	0 24 0 26	0 29 0 34	0 43 0 54	24
0 59 0 47	0 37 0 30	0 27 0 25	0 25 0 27	0 30 0 37	0 47 0 59	♑ 0
0 54 0 47	0 34 0 33	0 26 0 24	0 25 0 28	0 33 0 41	0 52 1 4	6
0 49 0 39	0 32 0 27	0 25 0 25	0 26 0 30	0 36 0 45	0 57 1 9	12
0 45 0 36	0 34 0 26	0 25 0 25	0 27 0 32	0 39 0 49	1 2 1 13	18
0 41 0 33	0 28 0 25	0 24 0 26	0 29 0 34	0 43 0 54	1 7 1 17	24
0 37 0 30	0 27 0 25	0 25 0 27	0 30 0 37	0 47 0 59	1 11 1 20	♒ 0
0 34 0 32	0 26 0 24	0 25 0 28	0 33 0 41	0 52 1 4	1 16 1 23	6
0 32 0 27	0 25 0 25	0 26 0 30	0 36 0 45	0 57 1 9	1 19 1 24	12
0 34 0 26	0 25 0 25	0 27 0 32	0 39 0 49	1 2 1 12	1 22 1 26	18
0 28 0 25	0 24 0 26	0 29 0 34	0 43 0 54	1 7 1 17	1 24 1 26	24
0 27 0 26	0 25 0 27	0 30 0 37	0 47 0 59	1 11 1 20	1 25 1 26	♓ 0
0 26 0 24	0 23 0 28	0 33 0 41	0 52 1 4	1 16 1 23	1 26 1 27	6
0 35 0 25	0 26 0 30	0 36 0 45	0 57 1 9	1 19 1 24	1 26 1 26	12
0 25 0 25	0 27 0 32	0 39 0 49	1 2 1 13	1 22 1 26	1 27 1 26	18
0 24 0 26	0 30 0 34	0 43 0 54	1 7 1 17	1 24 1 26	1 26 1 26	24
0 25 0 27	0 30 0 37	0 47 0 59	1 11 1 20	1 25 1 26	1 27 1 25	30
H.M H.M	H.M H.M	H M H.M	H.M H.M	H.M H.M	H.M H.M	

Example. able to the diuersitie of the ascension of eche halfe signe of the zodiake, as they doe follow in order. So that to come to an example, for declaration that I doe vnderstand that table: If I wolde knowe the quantitie of the vnequall houres, when the sun is in Aries and in his first degree, I must enter the first part of the table, where I finde on the left hand the signes and their degrees: wherefore against Aries and the cypher 0, which betokeneth the very beginning of the signe, I note al the houres as they follow in order: wherby I perceiue that the first houre of the day is but 25. minutes of an equall houre in length: the second houre is 27 minutes long: the third houre 30. minutes, that is half an equal houre iust: and in the same line going forward, the 12. & last houre of the day is 1 houre and 25. minutes in length. Then for the night the houres appeare in the other part of the table, where the first houre doth containe one equall or common houre, and 26 minutes: the second houre and the third be of like quantitie, and so doe they afterward decrease vntill the last houre of the night. Another example: when the sun is in the 10. degree of Cancer, because I cannot finde that degree in the table, I take the degree next vnto it, which is the 12 degree, and proceeding with it, I finde the first vnequall houre to containe 1. equall houre, and 19. minutes: and the second vnequall houre hath in it 1 equall houre and 24 minutes. Now for the night I looke in the 2. part of the table, and finde the first vnequall houre to be but 49 minutes in length, and the second but 39. minutes: and so in order following. This must I doe when the Sunne is in any of the North signes, but if the sunne be in anie of the south signs, then must we accompt the day houres in the second part of the table, and the houres of the night must be sought in the first part of the table: in all other pointes I perceiue there is small difference.

Example.

Maister.

Another for proportion. Yet by the way this may you note, that if you woulde desire more precisely to know the iust quantitie of the houres, for any such degree of ỹ signs as is not expressed in your table, you shal worke by the rule of proportion, to know the more exact quantitie of the vnequal houres. As for example: In the former worke where you supposed the sun to be in the 10 degree of Cancer, because that degree is not found in the table, you must worke by proportion to know it, and that in this forme. First consider the houres against the next number of degrees, as well beneath your degree as also aboue the same, and marke the difference between them two: which difference shal alwaies be the second number in the Golden rule: and the first number of that worke shal alwaies be 6. degrees, because that is the ordinary excesse in this table of eche two numbers next together. Now for the third nũber, you shal set the excesse of your degrees proponed, aboue the lesser degrees in that table, next beneath your said number, which in this example is 4. for so much is betweene 6 and 10. And the difference in houres in the table is but 3 minutes: for against the

6 degree

6 degree of Cancer, there is but one houre and 16 minutes : and againſt the 12 degree is ſet one houre & 19 minutes. Therefore thus doe I ſet thoſe numbers according to the golden rule, ſaying: If 6 degrees giue 3 minutes, then 4 degrees muſt yeeld two minutes. Theſe two muſt be added to the leſſer number, and ſo doth there riſe one houre & 18. minutes for the exact quantitie of the firſt vnequal houre, the ſun being in the 10. degree of Cancer.

6 3 — 4 2

Scholler.

I pray you let me proooue the ſame for the ſecond houre of the night, where againſt the 6. degree I finde 0 houre and 47 minutes : and againſt the 12. degree I ſee 0 houre, and 39. minutes, here the exceſſe is 8 minutes: then ſet I the figures thus in the golden rule, and ſay: If 6 yeeld 8, then 6 ſhal 4 giue 5. $\frac{1}{3}$: if I adde theſe vnto the leſſer number of time, which is 39 minutes,

6 8 — 4 5 $\frac{1}{3}$

Maiſter.

You are too farre deceiued, and therefore I interrupt your wordes, for al things are to bee gouerned by reaſon. So that if the houres doe increaſe in quantitie, then is it reaſonable to adde the part proportionable to the leſſer number of time, as it was in the former example: but in this example you ſee the time doth not increaſe, but decreaſe, (ſeeing the time againſt 6 degrees is greater then the time againſt 12. degrees) and therefore by good reaſon the part proportionable is to be abated from the greater, and not be added to the leſſer.

Scholler.

So is it reaſonable: therfore muſt I take this 5 $\frac{1}{3}$ from 47, and then reſteth 41, $\frac{2}{3}$, which is the preciſe quantitie of that vnequal houre. And now I thank you, I am fully inſtructed touching that matter : ſo that for anie vnequall houre according to the place of the ſun in this latter table, and after the lēgth of the day in the firſt table, I can find out the quantitie of eche vnequal houre: but theſe two formes do not make exactly one quantitie of hours vnequall.

Maiſter.

As in that you ſhal haue more exacter declaration hereafter. And for this preſent time I will ſay no more but that eche of both waies hath good vſes. And the firſt forme which ſeemeth moſt plaine and leaſt artificiall, hath comprobation of many men, and namely of Ptolomy in the 9 chapter of his 2. booke of Almageſtes. But omitting for a time that that remaineth touching houres, I will now ſpeake ſomewhat of the quantities of daies, in which matter you ſhall call to minde, that the Natural day is not one with the Artificial day: for the firſt is commonly accompted from ſun riſing one day, to ſun riſing the next day. But the ſecond, that is the Artificial day, is reckened onely from ſun riſing, to ſun ſetting: ſo that there is no night accompted in the artificiall day, as there is in the natural day.

Daies artificiel and natural.

Scholler.

Scholler.

This I perceiue well enough: and farther also, that the naturall dayes are euer 24 houres long, in all our knowne countries, but the artificiall dayes doe increase and decrease diuersly. And as I desire to know the causes therof, so I doe marueil how it commeth to passe, that in any countrey or climate the natural dayes should differ.

Maister.

To the intent that we may proceede orderly, wee will begin with the one sort of daies, and so come to the talke of the other. And first, as concerning Natural daies, I said that they were commonly accompted from sun rising to sun setting: which description being true, what shall we say of those north and south countries, where the sunne continueth aboue the horizonte in some places three weekes, in other fiue weekes, and so increasing till it extend to half a yere. In al which places if we call the natural day the space from sun rising to sun rising againe, then cannot the natural day be of one quantitie to al nations, and so should those daies naturall differ in nature, which were against nature vtterly: and therefore did I vse that word commonly in the former description: but if I shal define the natural day exactly, I must call it þ iust time in which the 8 sphere or firmament doth exactly accomplish his course, which time of natural day is the common measure of all other times: and this time is alwaies equal in al places, howbeit according to the former description, if the returning of the sun be accompted from any one part of the Meridian line, to the same part of the said line: then may that description wel extend to all partes of the world: for although some nations haue the sunne in sight halfe a yeare together; yet doth the sunne returne to their meridiane line toward the South at the end of 24 houres within a little, and in all places likewise where the day is not full foure and twentie houres, the Sunne doth returne to their Horizont, at the end of foure and twentie houres nigh hand.

The natural day.

Scholler.

I feare you speake in both these declarations, with a doubtful limitation of the 24 houres, as though that time were not the precise or iust measure of the naturall day.

Maister.

So shall it appeare vnto you, if you consider that the sunne doth euery day runne one degree almost toward the East, according to the succession of the signes, as before is mentioned: for if this day the sunne be in the first degree of Libra iustly at noone, then to morrow at noone hee will be in the second degree: and so the third day hence in the third degree: and by the same reason, at the monthes end will the Sunne haue passed Libra cleerely, and be in the beginning of the next Signe, which is Scorpius:

and

and therefore must hee be slacker in comming to the Meridian line, by so much time as serueth for the rising of all the signe of Libra in a right sphere.

Scholler.

That time must be an houre and 52 minutes. For (as I remember) the partes of the Equinoctial which do serue for the ascension of Libra, are 27. degrees and 54. minutes.

Maister.

As that is true, so marke what is the difference now for euery day of that moneth, and then shall you perceiue the difference of the naturall dayes, as much as dependeth of that cause.

The first cause of diuersitie in Naturall dayes

Scholler.

For the first degree of Libra, the quantitie of his ascention is 55 minutes of the equinoctial, which maketh in time of an houre 3 minutes and $\frac{2}{3}$, and so may I see for diuers degrees at the beginning of Libra, by the table of the ascensions in the Right sphere: but toward the end of the same signe, I see 57 minutes agreeing to the ascension of one degree, which maketh some difference in time also, though it be small.

Maister.

Marke now about the middle of Scorpius, how the degree of the zodiake hath one degree of the Equinoctiall agreeing to his ascention, which maketh in time 4 minutes of an houre: and about the middle of Sagittarius one degree of the zodiake hath answerable to him 64 or 65 minutes of the Equinoctiall. And so in other diuers degrees of Signes shall you finde diuers quantities of their ascensions, whereby it must needs appeare, that if the Sunne did moue forward in the zodiak euery day one degree iustly, that the sunne should be 4 minutes after the 24 houres slacker then hee was the day before in touching the meridiane line, if there were not another cause of diuersitie by the sundry quantities of the ascentions.

Scholler.

This cause is manifest. And because I see for some degrees of the zodiake but only 55 minutes of the equinoctial, which maketh in time 3 minutes and $\frac{2}{3}$: and for other degrees 65 minutes, which is 4 minutes and $\frac{1}{3}$: so doth it appeare that the greatest difference is but $\frac{1}{3}$ partes of a minute: which is a small matter.

Maister.

Yet this small matter wil cause much matter in Astronomical computations, though there were no more difference of diuersitie in Naturall dayes but this only: but yet are there two other causes in all oblique spheres, and but one in the Right sphere. The second common cause in both spheres, is the eccentricitie of the sunne.

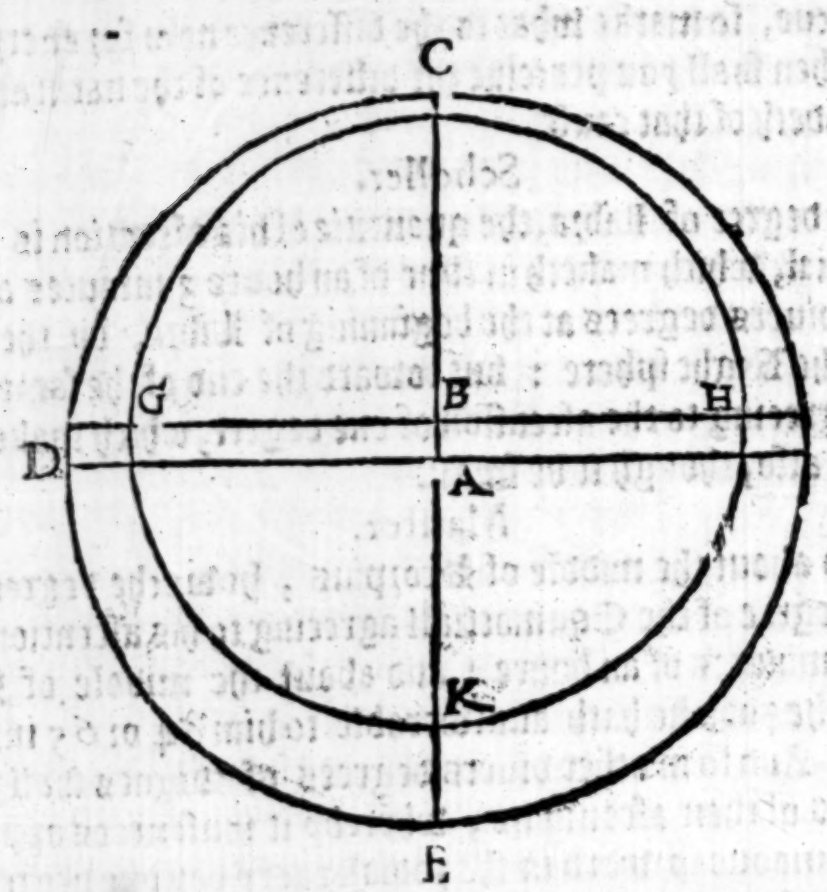
Scholler.

The second cause of vnequall naturall dayes.

What meane you thereby? For I doe not vnderstand that eccentricitie.

Maister.

It is a matter not agreeable for this treatise, but that by occasion I am mooued to name it as a concurrent cause touching inequalitie of naturall daies: yet somewhat to say of it as may suffice for this present, by example you shall vnderstand both what eccentricitie is, and also how it may cause diuersitie in natural daies: for declaration whereof here in this figure you see



two circles a greater and a lesser: the greater doth betoken the 8 sphere or firmament, and the lesser doth represent the eccentrike circle of the sphere of the sunne.

These two Circles as you see, are eccentrike, for that they haue not one common centre, sith the centre of the greater circle is by A, and the centre of the lesser circle is by B. the distance between A and B is the quantitie of their eccentricitie. Now may you see that eche circle is diuided into 4 quarters: and likewise you may see, that the higher halfe of the lesser circle doth not fully answere to halfe the greater circle: and againe the nether halfe of the lesser circle doth occupy more then the halfe of the greater circle. Whereby it must needs be euident to all men, that when the sunne moueth in the higher part of his eccentrike circle, he doth moue slowlier then he doth in the nether part of the same eccentrike: I meane in comparison to the zodiake of the 8. sphere: and thereby must it appeare that the sunne doth not euery day moue like number of minutes in the zodiake: and you may easily coniecture hereby, that this is another cause of diuersitie in the quantitie of the naturall

dayes.

dayes. A third diuersity is that which is peculiar to euery seuerall climate, and not common to any two on one side of the equinoctiall, and that is the obliquity of the horizont, if the day shall be accounted from Sunne rising to Sunne rising againe: but this variety is so great and so diuers, that it is in maner infinite: & therfore do Astronomers reiect that order of accounting of dayes, and recken the day from noone to noone, which account serueth generally for all the parts of the world, as if all climates had one horizont: for as in the right sphere both the Poles do touch the horizont, so the meridianes of euery climate and of all regions doe passe by both the Poles of the worlde: and therefore all ascentions accounted vnto that meridiane line, must be esteemed as right ascentions, I meane ascentions like vnto them that be in the right sphere.

The third cause of diuersitie of dayes naturall.

Scholler.

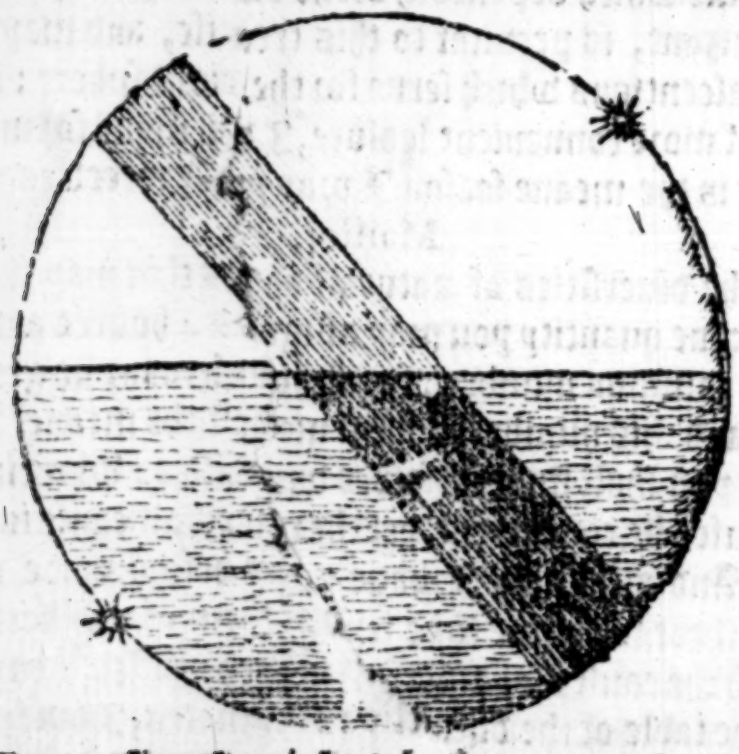
Now do I perceiue, that although there may be assigned three causes of varietie in the naturall dayes, yet one of them which is gathered by the obliquity of the horizont is not regarded of Astronomers, sith they doe account the beginning of the day from the noone sterd, and the Sunne being in the meridian line. The second cause by the eccentricity of the Sunne I may coniecture to appertaine to a more higher speculation, then this treatise doth admit: but yet may be somewhat vnderstood euen now by a small explication. The third cause which dependeth of the diuersity of the ascentions by obliquity of the horizont, is peculiar to this treatise, and may be gathered out of the tables of ascentions which serue for the right sphere: of al which varieties at a time of more conuenient leasure, I will make for mine exercise a table at large: but in the meane season I pray you proceed as you haue begun.

Maister.

Touching the diuersities of naturall days this may suffice: and for a common and meane quantity you may assigne 24 houres and 4 minutes, because that is the common number: for although many be greater, yet many other be lesser: and this number is most nigh est the meane. Now touching artificiall dayes you shall finde no fewer diuersities: wherein although al the former three causes be concurrent, yet the principall cause is the obliquity of the horizont. And although I haue twice before made mention of those dayes, yet doth there rest more to be say of them: for in both places before I did briefly touch the causes of diuersi of such artificiall dayes in diuers climates, and in the table of the distinction of climates, I did set forth the quantity of the longest day in ech of them: and now will I shew you somewhat of the reason of their inequality in any one climate. First therefore to beginne withall, you know that before the Sunne in his naturall course can passe the full of one degree, he is carried by the violence of the starry skie round about the earth: so that in going betweene the first degree of Capricorne, and the first of Cancer he doth consume halfe a yeare, and therefore maketh aboue

The diuersitie of the artificiall dayes.

182 reuolutions like spirall circles, which are diuersly parted by the Horizont, according to the diuersities of the eleuation of the pole. As in the Right sphere they are all parted by the Horizont into two equall partes: so in euery bowing sphere, they are vnequally diuided by the horizont, so that where the north pole is eleuate aboue the horizont, there those circles of the sunnes reuolutions which be from the equinoctial northward, haue the greater portion aboue the horizont, and the lesser part vnder the same: and contrariwise those circles (or spires if you like better so to call them) which be from the equinoctiall to the tropike of Capricorne, and serue for explication of the sunnes motion, they haue their greater portion vnder the horizont, and the lesser portion aboue the same. And comparing eche one of these to other, that circle which is farthest toward the South, is most part vnder the horizont of any other. And euery one of them the more it departeth from the South and draweth toward the north, the greater is his portion that is aboue the horizont, and the lesser is that other portion which is vnder the same. Wherfore the middlemost bound of these two extreames, is iust halfe vnder, and and halfe aboue the Horizont: and therefore the sunne being in it, doth make his abode iust like time aboue the earth, as he doth vnder it, and thereby the daies and nights are equall: but from thence toward Cancer, the day doth still increase aboue the night: and from thence toward Capricorne, the day



doth still abate shorter then the night: which thing will easily appeare to the sight, both by these figures here drawne, and also by the diuers positions of the materiall sphere or globe. And still the higher that the pole is eleuate aboue the horizont, the greater part of the northerly circles is aboue the horizont, and the lesser part of them vnder the Horizont. And contrariwise of the Southerly circles, the greater portions of them are vnder the Horizont,

and

and the lesser portions aboue it. Now it is easily perceiued, that seeing the sunne doth keep his dayly course in one of those circles, then accordingly as that circle in which the sunne doth mooue, is parted by the horizont, so is the partition of the 24. houres into day and night agreeably: so that if the circle of the sunnes course be more vnder the horizont then aboue it, then shall the night be longer then the day: and if the greater part of the sunnes circle be aboue the horizont, then the day shall exceed the night, in like proportion as the partes of the circles are in comparison togither.

Scholler.

These diuers circles (I perceiue) are not in the sphere of the sunne, but are accompted in the right sphere betweene the two tropikes, so that euery day by the reuolution of the Firmament, the sunne is caried from East to West round about ỹ earth, & by this violent motion doth describe a spirel circle (as you call it) & not an exact circle: but yet may it serue in this case, as if it were a iust circle: the difference is so litle of the space between the spiral lines in cõparison to their cõpasse, which by the table of ỹ declination before expressed, I gesse it to be in proportion scarse $\frac{1}{1000}$, which is no part notable in this case. And this farther I note: that two circles on contrary partes of the Equinoctiall equally distant from it, are parted by the horizont after one rate, and into like portions: but yet in such difference, that the part of the one circle aboue ground, is equal to the part of the other that is vnder ground: and so contrariwise. Whereby it followeth, that the day of the one is equall to the night of the other, and so contrariwise also. Again, seeing that the sun doth descend from Cancer vnto Capricorne, by the same circles of reuolution, by which hee did ascend from Capricorne vnto Cancer, it must needes followe that euery two dayes in the yeare equally distant from the longest day, or from the shortest, are equall in their artificiall day, and in their night. These general things I may easily gather: but how I may know iustly the quantitie of euery artificial day from other, and the precise time of the sunne rising and setting, I cannot so easily gather. Wherefore if it please you in those 2. points I desire your instruction.

Maister.

Although for this treatise the aptest forme be by the vse of the sphere and the due placing of it, yet it is hard to place the sphere so well, and to vse it so aptly, that it might declare a iust precisenesse. And therfore after that I haue taught you the vse of the sphere for that point, I will also by supputation giue you a table sufficient to declare both vnto you for all partes vnder our paralel, and somewhat more. First for the vse of the globe, you must set it according to the latitude of the Region that you desire to know the dayes in, and then marke the degree of any signe that the sunne is in that day, whose

The fourth Treatise of

A Table for conuerting degrees of the Equinoctiall into partes of time.

The arke of the Equinoct.	Parts of time.		The arke of the Equinoct.	Parts of time.		The arke of the Equinoct.	Parts of time.	
Degree	Houres	Minutes	Degree	Houres	Minutes	Degree	Houres	Minutes
1	0	4	75	5	0	205	13	40
2	0	8	80	5	20	210	14	0
3	0	12	85	5	40	215	14	20
4	0	16	90	6	0	220	14	40
5	0	20	95	6	20	225	15	0
6	0	24	100	6	40	230	15	20
7	0	28	105	7	0	235	15	40
8	0	32	110	7	20	240	16	0
9	0	36	115	7	40	245	16	20
10	0	40	120	8	0	250	16	40
11	0	44	125	8	20	255	17	0
12	0	48	130	8	40	260	17	20
13	0	52	135	9	0	265	17	40
14	0	56	140	9	20	270	18	0
15	1	0	145	9	40	275	18	20
20	1	20	150	10	0	280	18	40
25	1	40	155	10	20	285	19	0
30	2	0	160	10	40	290	19	20
35	2	20	165	11	0	295	19	40
40	2	40	170	11	20	300	20	0
45	3	0	175	11	40	305	20	20
50	3	20	180	12	0	315	21	40
55	3	40	185	12	20	330	22	0
60	4	0	190	12	40	340	22	40
65	4	20	195	13	0	350	23	20
70	4	40	200	13	20	360	24	0

quantitie you desire to know: set that degree iust in the horizont toward the east, and marke what degree of the equinoctiall is in the horizont at the same time: then turne the sphere westward til the degree of the sunne be iust in the horizont againe in the west part, and marke then what degree of the Equinoctiall doth light on the horizont in the east part, accounting truely howe many degrees be betwixt those two degrees which you haue marked, and that arke of the Equinoctiall is called the arke of that day: which you may easily turne into houres, accounting 15. degrees to an houre, and for euery degree lesse then 15. accounting 4. minutes of an houre.

Scholler.

This were easie inough to do, if I vse the help of the Table that I see in some bookes, which teacheth easily how to turne degrees of the Equinoctiall into partes of time, as here in Orontius worke it is set foorth: but I did abridge it for my selfe as in the page aforegoing appeareth: and because the table was not extended aboue 60. degrees by Orontius, I did for mine owne ease make out the rest in this forme.

Maister.

This is a table of too much ease, and therefore rather teacheth negligence then any thing else: for him that listeth to exercise his wit in readinesse of account, it is an easie matter to turne degrees into houres without any tables, and therefore such tables might well be spared, and yet many bookes are ful of them: but if you listed, you might haue abridged it more from 15 vpward, taking only euen 15 still, as thus, 15, 30, 45, 60, 75, &c. so seemeth al the rest superfluous, except your number of degrees in the day arke happen iust agreeable with some one of those in the table: but now to proceede, giue one example for declaration of your vnderstanding herein.

Scholler.

Then to beginne, I set the globe to the elevation of 52 degrees, and consider the place of the sunne the 14 day of August, and finde it to be by the Ephemerides, in the first beginning of Virgo, therefore do I set the beginning of Virgo in the very horizont, and then do I see with it the 137. degree of the equinoctiall in the same horizont, which I do marke: afterward I turne the sphere til the place of the sunne be in the horizont on the west part, and then in the east part I marke the degree of the Equinoctiall, which is 347. degrees. Now abating 137. out of 347, there resteth the whole day arke, which is 210 degrees, which make 14 houres, as by the former table is easily seene: wherefore I conclude that the 14 day of August, the sunne shineth 14 houres, and then must the night be but euen ten houres, sith both times make iust 24. houres: but yet I see not how to know the houres of the sun rising and setting. Example.

347
137
210

Maister.

I am sure you thinke that the Noone is the middle of the day, and that the sunne shineth like space before noone and after noone.

Scholler.

That is most certaine.

Maister.

Then parting the whole time of the sunne shining, or of the artificial day into two equall partes, the one halfe doth limite the houre after noone at which the sunne doth set.

Scholler.

That is in this example 7, and so must it needes be. And nowe I see by the same reason, the sunne must rise 7 houres before noone, that is at five of the clocke in the morning.

Maister.

So is it. And for that end that you may haue a generall rule therein, euermore abate halfe the quantitie of the day from 12 houres, and then will the remainder declare the iust houre and minute of the sun rising.

Scholler.

Example. Then by your fauour I will proue once againe: wherefore I take the 16. day of July, the sun being in the 3 degree of Leo, which degree I set in the East part of the horizont, and then doth there appeare in the same horizont the 98. and almost $\frac{1}{3}$ degree of the equinoctial: then turning the degree of the sunne to the West part of the horizont, I finde in the East part the 332. and $\frac{1}{3}$ almost of the equinoctial: then subtracting the lesse from the greater, there resteth 234: which I turne into partes of time, and it doth yeeld 15. houres and 36 minutes. Which is the iust length of that artificiall day. And of it the one halfe is 7 houres and 48 minutes, whereby I know, that at 48. minutes after 7 of the clocke at night, the sun setteth on that 16 day of July: and then abating so much from 12. there resteth 4 houres and 12 minutes: so that the sunne rising appeareth to be 12 minutes after 4. of the clocke in the morning. And now I thinke my selfe cunning inough in all this matter.

332	$\frac{1}{3}$
98	$\frac{1}{3}$
234	
12	0
7	48
4	12

Maister.

Yet for more ease: after you haue noted the degree of the Equinoctial that doth rise with the place of the sunne, you may marke the degree that riseth with the contrary point against the sunne: and abate then the first out of the second, and so accomplish your worke, as you did before. For it is all one thing, but that you need not to looke on contrary sides of your sphere for your worke. And this shall you note further: that if the first ascension of the place of the sunne be greater then the second ascension of the Nadir of the sun, you shall put to the second ascension, 360 degrees, and then abate as you are taught before. As for example: the first day of February the sunne is by the Ephemerides in the 22. degree of Aquarius, that degree I finde in the

A Cautele.

Example.

Zodiake

zodiake of my sphere and I set it iust in the East part of the horizont, and there may I see that the 343 1/3 degree of the equinoctiall doeth ascend at the same instant in the horizont also: which I must account for the true ascention of the degree of Aquarius. Then turne I to the 22 degree of Leo, being the nadir of the Sunne, and with it when it is set in the horizont, I marke the 125 1/3 degree of the equinoctiall to ascend. Now when I would subtract 343 1/3 out of 125 1/3, it will not be: and therefore I put vnto the lesser number 360, and so it amounteth to 485 1/4, and then from it I abate 343 1/3, and there remaineth 142 5/12: which if you chaunge into partes of time, doe make 9 houres and 30 minutes: and that is the quantity of the first day of Febzuary.

Scholler.

The halfe of that is 4 houres and 45 minutes, whereby I knowe, that at the 45 minute that is 3/4 of an houre after 4 of the clocke the sunne setteth: and riseth in the morning 15 minutes, that is 1/4 of an houre after 7 of the clocke. But why do you adde those 360 degrees?

Maister.

Seeing we intend to abate the first ascention out of the second, to the intent that their distance may be knowen, seeing the whole compasse of the circle is but 360, from which if you abate the first ascention being the greatest number, then will there remaine the distance betweene that ascension and the ende of the equinoctiall: vnto which difference you must adde so many degrees as the second ascension requireth, as both reason and practise will declare vnto any man,

Scholler.

It is reasonable. Therefore nowe it may please you to declare the same worke by exactnesse of tables.

Maister.

The declaration of the tables.

Because you shall not be driuen to seeke in the Ephemerides for the place of the Sunne, but that one table may serue for it, aswell as for the quantities of dayes and other conclusions also, I will make the tables common for sundry vses, whose parts I will first declare, and after that will expresse the vses of them also.

In the first columne are set the dayes of the monethes, and in the second the degrees of the signes in the zodiake, in which the Sunne is that day: so likewise the third & fourth columne do serue for the like matter, seeing twice in the yere the dayes are equall. And because at other 2 times in the yere the nights are equall to those dayes, therefore on the right hand of the table are there 2 columnes of moneths, and other two columnes of signes agreeable thereto, in which those nights are equall with the dayes of the moneths on the left hand, and therefore are the titles set ouer the signes and moneths on

The Tables of Quantities of dayes Artificiall, and nights, for all England.

Signes for the day.					Elevation of the Pole, or latitudes of Regions.					Signes for the night.				
Dayes of moneths.	Signes.	Degrees of	moneths.	Dayes of	Signes.	Degrees of	51	52	53	54	55	Signes.	Degrees of	Dayes of moneths	Signes	Degrees of	Dayes of moneths
10	♈	0		13	30	12 0	12 0	12 0	12 0	12 0		0	♎	13	♓	30	10
11		1		12	29	12 4	12 4	12 4	12 4	12 4		1		14		29	9
12		2		11	28	12 8	12 8	12 8	12 8	12 8		2		15		28	8
13		3		10	27	12 12	12 12	12 12	12 12	12 14		3		16		27	7
14		4	APRIL	9	26	12 16	12 16	12 16	12 18	12 18		4		17	SEPTEMBER	26	6 MARCH
15		5		8	25	12 20	12 20	12 21	12 22	12 23		5		18		25	5
16		6		7	24	12 24	12 24	12 26	12 26	12 28		6		19		24	4
17		7	MAY	6	23	12 28	12 28	12 30	12 30	12 32		7		20		23	3
18		8		5	22	12 32	12 32	12 34	12 35	12 36		8		21		22	2
19		9		4	21	12 36	12 36	12 38	12 40	12 40		9		22		21	1
20		10		3	20	12 40	12 40	12 42	12 44	12 44		10		23		20	29
21		11		2	19	12 44	12 44	12 46	12 48	12 48		11		24		19	28
22		12		1	18	12 48	12 48	12 50	12 52	12 54		12		25		18	27
23		13		31	17	12 52	12 54	12 54	12 56	12 58		13		26		17	26
24		14		30	16	12 56	12 58	12 59	13 1	13 3		14		27		16	25
25		15		29	15	12 58	13 2	13 4	13 6	13 8		15		28		15	24
26		16		28	14	13 2	13 6	13 8	13 10	13 12		16		29		14	23
27		17		26	13	13 6	13 10	13 12	13 14	13 17		17		30		13	22
28		18		25	12	13 10	13 14	13 16	13 18	13 22		18		1		12	21
29		19		24	11	13 14	13 18	13 20	13 22	13 26		19		2		11	20
30		20		23	10	13 18	13 22	13 24	13 27	13 31		20		3	OCTOBER	10	19
31		21		22	9	13 22	13 26	13 28	13 32	13 36		21		4		9	18
1		22		21	8	13 26	13 30	13 32	13 36	13 40		22		5		8	17
2		23	AVGVST.	20	7	13 30	13 34	13 36	13 40	13 41		23		6		7	16 FEBRVARIE
3		24		19	6	13 34	13 38	13 40	13 44	13 48		24		7		6	15
4		25		18	5	13 38	13 42	13 44	13 48	13 52		25		8		5	14
5		26		17	4	13 42	13 46	13 49	13 52	13 57		26		9		4	13
6		27		16	3	13 46	13 50	13 54	13 58	14 2		27		10		3	12
7		28		15	2	13 50	13 52	13 58	14 2	14 6		28		11		2	11
9		29		14	1	13 52	13 56	14 2	14 6	14 11		29		12		1 ♓	10
10		30		12	0	13 56	14 0	14 6	14 10	14 16		30		13		0	9
						H.M	H.M	H.M	H.M	H.M							

The second part of the Table.

Signes for the day.				Eleuation of the Pole, or latitude of regions.					Signes for the night.			
Dayes of monethes.	Degrees of Signes.	Dayes of monethes.	Degrees of Signes.	51	52	53	54	55	Degrees of Signes.	Dayes of monethes.	Degrees of Signes.	Dayes of monethes.
10 APRIL	♉ 0	13	30	13 56	14 0	14 6	14 10	14 16	♍ 0	13	30	9 FEBRVARY
11	1	12	29	14 0	14 4	14 10	14 14	14 20	1	14	29	8
12	2	11	28	14 4	14 8	14 14	14 18	14 24	2	15	28	7
13	3	10	27	14 8	14 12	14 18	14 22	14 28	3	16	27	6
14	4	9	26	14 12	14 16	14 22	14 26	14 32	4	17	26	5
15	5	8	25	14 14	14 20	14 26	14 30	14 37	5	18	25	4
16	6	7	24	14 18	14 24	14 30	14 34	14 42	6	19 OCTOBER	24	3
17	7	6	23	14 22	14 28	14 33	14 38	14 46	7	20	23	2
18	8 MAY	5	22	14 26	14 32	14 36	14 43	14 50	8	21	22	1
19	9	4	21	14 30	14 34	14 40	14 48	14 54	9	22	21	31
20	10	3	20	14 34	14 38	14 44	14 52	14 58	10	23	20	30
21	11	2	19	14 36	14 42	14 48	14 56	15 2	11	24	19	29
22	12	1	18	14 40	14 46	14 52	15 0	15 6	12	25	18	28
23	13	31	17	14 44	14 50	14 56	15 3	15 10	13	26	17	27
24	14	30	16	14 46	14 54	15 0	15 6	15 14	14	27	16	26
25	15	29	15	14 50	14 56	15 4	15 10	15 18	15	28	15	25
26	16	27	14	14 54	15 0	15 8	15 14	15 22	16	29	14	24
27	17	26	13	14 56	15 4	15 11	15 18	15 26	17	30	13	23
28	18	25	12	15 0	15 8	15 14	15 22	15 30	18	31	12	22
29	19	24	11	15 4	15 10	15 17	15 26	15 34	19	1	11	21
30	20	23	10	15 6	15 14	15 20	15 30	15 38	20	2	10	20
1 IVNE	21	22	9	15 10	15 18	15 24	15 34	15 42	21	3 NOVEMBER	9	19
2	22	21	8	15 12	15 20	15 28	15 37	15 45	22	4	8	18
3	23	20	7	15 16	15 24	15 32	15 40	15 48	23	5	7	17
4	24	19	6	15 18	15 28	15 36	15 44	15 52	24	6	6	16
6	25	18	5	15 22	15 30	15 39	15 47	15 55	25	7	5	15 DECEMBER
7	26	17	4	15 24	15 34	15 41	15 50	16 0	26	8	4	14
8	27	16	3	15 28	15 36	15 44	15 54	16 4	27	9	3	13
9	28 IVLY	15	2	15 30	15 40	15 47	15 57	16 7	28	10	2	12
10	29	14	♌ 1	15 34	15 42	15 50	16 0	16 10	29	11	1 ♒	11 IANVARIE
11	30	13	0	15 36	15 44	15 54	16 4	16 14	30	12	0	10
				H.M.	H.M.	H.M.	H.M.	H.M.				

The third part of the Table.

Signes for the day.				Eleuation of the Pole, or latitude of regions.					Signes for the night.				
Dayes of monethes.	Degrees of Signes.	Dayes of monethes.	Degrees of Signes.	51	52	53	54	55	Degrees of Signes.	Dayes of monethes.	Degrees of Signes.	Dayes of monethes.	
11	♈ 0	13	30	15 36	15 44	15 54	16 4	16 14	0 ♎	12	30	10	
12	1	12	29	15 38	15 46	15 56	16 6	16 17	1	13	29	9	
13	2	11	28	15 41	15 49	15 59	16 9	16 20	2	14	28	8	
14	3	10	27	15 44	15 52	16 2	16 12	16 24	3	15	27	7	
15	4	9	26	15 46	15 54	16 4	16 14	16 26	4	16	26	6	
16	5	8	25	15 49	15 57	16 7	16 17	16 29	5	17	25	5	
17	6	7	24	15 52	16 0	16 10	16 20	16 32	6	18	24	4	
18	7	5	23	15 54	16 2	16 12	16 22	16 34	7	19	23	3	
19	8	4	22	15 56	16 5	16 15	16 25	16 37	8	20	22	2	
20	9	3	21	15 58	16 8	16 18	16 28	16 40	9	21	21	1	
21	10	2	20	16 0	16 10	16 20	16 30	16 42	10	22	20	31	
22	11	1	19	16 2	16 12	16 22	16 32	16 44	11	22	19	30	
23	12	30	18	16 4	16 14	16 24	16 34	16 46	12	23	18	29	
24	13	29	17	16 5	16 15	16 26	16 36	16 48	13	24	17	28	
25	14	28	16	16 6	16 16	16 28	16 38	16 50	14	25	16	27	
26	15	27	15	16 8	16 18	16 30	16 40	16 52	15	26	15	26	
28	16	26	14	16 9	16 19	16 31	16 42	16 54	16	27	14	25	
29	17	25	13	16 10	16 20	16 32	16 44	16 56	17	28	13	24	
30	18	24	12	16 12	16 22	16 34	16 46	16 58	18	29	12	23	
31	19	23	11	16 13	16 23	16 35	16 47	16 59	19	30	11	22	
1	20	22	10	16 14	16 24	16 36	16 48	17 0	20	1	10	21	
2	21	21	9	16 15	16 25	16 38	16 50	17 2	21	2	9	20	
3	22	20	8	16 16	16 26	16 38	16 51	17 3	22	3	8	19	
4	23	19	7	16 17	16 27	16 39	16 52	17 4	23	4	7	18	
5	24	18	6	16 18	16 28	16 40	16 52	17 4	24	5	6	17	
6	25	17	5	16 19	16 28	16 40	16 53	17 5	25	6	5	16	
7	26	15	4	16 20	16 29	16 41	16 54	17 5	26	7	4	15	
8	27	14	3	16 20	16 30	16 42	16 54	17 6	27	8	3	14	
9	28	13	2	16 20	16 30	16 42	16 54	17 7	28	9	2	13	
10	29	12	♉ 1	16 20	16 30	16 43	16 54	17 8	29	10	1 ♑	12	
11	30	11	0	16 20	16 30	16 44	16 54	17 8	30	11	0	11	
				H.M.	H.M.	H.M.	H.M.	H.M.					

MAIE IVNE IVLY NOVEMBER DECEMBER IANVARIE

the left hand, signes for the day: and on the right hand signes for the night: that is to say, that if the moneth and signe for which you seeke, be on the left side of the table, then doe the numbers vnder the eleuation of the pole declare the quantitie of the day: but if the monethes and signes be on the right side, then is that quantitie the length of the night. And ouer the 5. middle pillers, you see the tittle to be the Elevation of the Pole, or latitude of regions, which are there but onely 5 expressely set, namely 51. 52. 53. 54. and 55: which may serue for all England, from the South sea vnto Scotland. And so may it doe for diuers of the north partes of Europe and Asia. Now for the vse of them, this is the order: When soeuer you would know the quantitie of the day artificiall and of his night, seeke out the day in the columnes on the right hand, or on the left hand as it will chaunce, and by it in the next column you may see the place of the sunne in the zodiake: then going right forth toward the middle of your table till you come directly vnder the columne that serueth for your Region in latitude, there shall you finde two numbers, the first betokening houres, and the second minutes of houres, which declare the iust quantitie of the day for the monethes on the left hand: or els if the moneth that you seeke for be on the right hand, then doe those nombers of houres and minutes betoken the quantitie of the night.

Scholler.

I perceiue it well, and I see by reason it must needs be so: as for examples sake, The 24 day of August I desire to know the length of the day and the place of the sun in the zodiak: wherefore finding the said 24 day in the first table of those three right against it, I may see the place of the sunne, which is then the 11 degree of Virgo: and from thence proceeding forth right toward the middle of the table, I finde vnder the number of 52, degrees of latitude 13. houres and 18. minutes: whereby I perceiue that the Artificiall day from sun rising to sun setting, is so long with vs: and the night is the rest of 24 houres, that is 10 houres and 42 minutes. And the like quantities of day and night must needes be the 29. day of march, when the sunne is in the 19 degree of Aries. But on the 20 day of Februarie, the sun being in the 11 degree of Pisces, that 13 houres and 18 minutes is the quantity of ỳ night, and the day then is but 10 houres and 42 minutes in length: and so likewise the second day of October, when the sunne is in the 19 degree of Libra.

Maister.

This is sufficient: for as you haue done in this, so may you doe in all other like. Yet for the more certaintie I will proue you with one question more: For London which is supposed to be 51. degrees and 24 minutes in Latitude, I would know the quantitie of the day Artificiall when the sun is in the 28 degree of Scorpio.

Scholler.

I finde that signe of Scorpio in the second table on the right hand, and the 10 day of November answering vnto it. And because 24. minutes are lesse then halfe a degree, I doe seeke the quantitie of the day vnder 51 degrees rather then vnder 52, and so finde I 15 houres and 30 minutes: which in this case is the quantity of the night, as the title declareth, that is ouer those signs: therefore the length of the day is 8 houres and 30 minutes.

A cautele for the part proportionable.

Maister. You haue done wel. But yet for an exacter preciseneſſe, you may take the part proportionable for the odde minutes of the eleuation, as thus: for the latitude of 51. degrees, the day is 8 houres and 30 minutes: and for 52 degrees, it were 8 houres and 20 minutes: so are there 10 minutes difrence between those two eleuations. Then say by the golden rule: If 60 minutes giue 10, what shal 24 minutes giue? and it wil appeare to be 4. minutes. Those 4 minutes must I abate from the greater number in this example (and in al this worke where the numbers decrease) and it will yeeld 8 houres & 26 minutes: where as if you did find the numbers to increase, then should you adde those partes proportionable vnto the lesser number, as by proofe you may trie, for that day when the sun is in the second degree of Leo.

60 ⊿ 10
24 ⊿ 4

Scholler.

That is (by the second table) the 15 day of July, and then is the day in length 15 houres and 30 minutes, in the latitude of 51 degrees: but in the latitude of 52 degrees, it is 15. houres and 40 minutes, so it increaseth 10. minutes: and therefore must I adde the part proportionable (which is 4 minutes as before) vnto 30. And so haue I ỹ true quantitie 34. minutes aboue 15 houres. And now I think I am perfect enough for al places between 51 degrees of latitude and 55: but for other places I know no such way.

Maister.

It were too long a worke to set out all diuersities of eleuations, & scarse agreeable for this treatise, where these things are but incident, and not principal matters: but at other times in more conuenient place it shalbe done, if I may vnderstand this my labour to be profitably imploied. And then also will I make explication of diuers other matters, which you did in your table at the beginning of this treatise propound, although at this time I thinke many of them little appertaining to this booke. But yet before I end this treatise,

Constellations

I must speake somewhat of two or three matters more: And first of the chief Constellations and figures in the Starrie skie: For a ground you shal note, that the stars are not only in multitude infinit, but many of them also so smal, that scarse any mans eie can discern them. Wherfore to auoid confusion, and to grow to a certaintie, the ancient astronomers did note only 1022. starres, whereof the most part they did assigne to certain limites, enclosing them in figures of men, beasts, or other forms, & accordingly gaue them names, partly

that

that they might the more easily be remembred, partly for remembrance of some worthy fact, and partly also for some notable signification of the starres comprehended in eche of them. All which matters I will now ouerpasse, til a more conuenient place, and will repeate only their names and places generally, distincting them according to the accustomed maner, into three sortes: whereof the one sorte are called northerly constellations, the other sorte southerly constellations, and the third sort are the 12 signes, which passe in the middle betweene south and north: for here in this place I meane not to referre South and North to the poles of the Equinoctial, but as all learned men before me haue done, to the poles of the zodiake. And so may the zodiake be accompted exactly in the middle. But now to begin as *Ptolomy* doth, with the northerly constellations. The most northerly constellation is the lesse Beare, called *Vrsa minor*, and *Cynosura*, and containeth in it 7 starres. This is the chiefe marke whereby mariners gouerne their course in sayling by night, and namely by two starres in it, which many doe call the Shafte, and other doe name the *Guardas*, after the Spanish tongue. Nigh vnto it is the greater Beare, called *Vrsa maior*, cõtaining 27 stars, whereof 7 are most notable, and are in Latine named *Plaustrum*, and in English Charles Waine, which serueth also wel in sayling: and many of the old Greekes obserued it only in their nauigatiõ, as the Sydonians & al the Phenicians marked the lesser Beare. About these 2 Beares is there a long trace of 31 stars, cõmonly called the Dragon. Then followeth *Cepheus*, which consisteth of 11 stars. Bootes also is in the same coast, whom Proclus and others doe name Arctophylax: and it hath 22. starres, besides one very bright starre called Arcturus, which standeth betweene Bootes legges. By Arctophylax right hand, is the north Crowne, called also Ariadnes Crowne, and hath in it 8 stars. Then followeth Hercules, whom the Greeks call Engonasin, as it were the Kneeler, bicause of his gesture, & it containeth 28 starres. By his left hand is there another constellation, which is called the Harp, in latin *Lyra* and *Ficidula*, and also *Vultur cadens*, that is, the falling Gripe, it comprehendeth 10 starres. By it is the Swan named *Cygnus*, and *Auis* generally, as the Greeks call it *Ornis*, which some men of too much ouersight do translate *Gallina* a Hen: it consisteth of 17 starres. After it doth Ptolomy reckon Cassiopeia, which is by Cepheus, & hath 13 starres. Next vnto her is Perseus, with Medusaes head, and it includeth 26 starres. Then followeth Erichthonius with the Goate and the two Kids: this constellation is also named *Auriga* the Carter, & containes 14 stars, with one in his right foot that is common to Taurus also. Another constellation is there which ioynes head to head with Hercules, & is called of the Greekes, *Ophiuchus*, of the Latines *Serpentarius*, that is, the man with the Serpent, or Serpent-bearer: and it hath 24 starres. Beside the Serpent, which containeth 18 stars in himselfe, and

The north constellations.

1 Vrsa minor.

2 Vrsa maior.

3 Dragon.

4 Cepheus.

5 Bootes.

6 The north Crowne.

7 Hercules.

8 Lyra.

9 The Swan.

10 Cassiopeia.

11 Perseus.

12 The Carter.

13 Serpentarius.

14 The Serpent.

and is named of the Latines *Anguis*, and of the Greekes *Ophis*. Then is there another small constellation of 5 starres, a litle South of the Swannes head, and it is named the Dart, *Sagitta* or *Telum* in Latine, and in Greeke *Oistos*. By it toward the South, is the Egle, including 9 starres: he is called not onely *Aquila* in Latine, but also *Vultur volans*, and in Greeke *Aetos*. Under it towarde the South is a constellation hard adioyning, named *Antinous* in all tongues, and hath but 6 starres. A litle from it is the Dolphin, which hath in it 10 starres.

15 The Dart.

16 The Egle.

17 Antinous.

18 The Dolphin.

Then foloweth the Foxehorse, noted with 4 darke stars, and hard by him is the Flying horse, named *Pegasus*: and both consist of 20 starres. Unto him ioyneth *Andromeda*, so that her head lieth on the nauell of *Pegasus*, and one starre is common to them both. This constellation doth containe 23 starres.

19 The Foxe horse.

20 The Fliyng horse.

By her left foote is there a small constellation of 4 starres, which is commonly called the Triangle, and in Latine *Triangulus*, but the Greeks name it after one of their letters *Delta* and *Deltoton*. And thus haue I briefly reckoned all the Mothly constellations, except Berenices haire, of which I wil speake last of all other. And therefore nowe next in due order must the 12 signes followe: among which Aries occupieth the first place, and containeth 13 starres. Then Taurus which is adorned with 33 starres, whereof 5 be in his forehead and face, and are called of the Grecks *Hyades*, and of the Latines *Succulæ*: amongst which, one is more notable then all the rest, & is called *Oculus Tauri*, the Bulles eye: but the Greeks call it *Lampadias*, and the Latines *Palilicium*: the Arabitians *Aldebaran*. Other 6 barres (as Proclus numbreth them, though other account them 7) are in the backe of this signe, and be called *Vergiliæ* in Latine, and in Greek *Pleiades*, and also *Atlantides*: they are named in English the Brood hen, and the Seuen starres, yet they cluster so nigh together, that it is hard to number them truely: and therefore many do disagree in reckoning them.

21 Andromeda.

22 The triangle.

1 Aries.

2 Taurus. Water starres.

The seuen starres.

After Taurus, Gemini do follow, which comprehend 18 stars: of which two beare name as most famous, and they are in their heads: the formost is named Apollos head, and the next is called Hercules head, because those two Twinnes were so named of some men, yet other doe call them Castor and Pollux. Before their formost foote there is one faire starre (beside the 18) which therefore is named in Greeke *Propus*. After Gemini followeth Cancer containing 8 starres, beside a cloudy tract which is named the Manger or Cribbe. Other two starres are called the Asses which seeme to stand at the Cribbe. Then the Lion is next, as a princely signe, in whom are 27 starres, but two of them are more notable then the rest: the one is in the taile, and therefore is called *Cauda Leonis*, the other in the brest, and is called the Basilyske or Kingly starre, and also the Lions heart, *Cor Leonis* in Latine, and *Basiliscos* in Greeke. Next after Leo cõmeth Virgo garnished with 26 stars, but

3 Gemini.

Propus.

4 Cancer. Cribbe. Asses.

5 Leo.

6 Virgo.

but one especially glistereth aboue the rest, and is called *Spica Virginis*, the Virgins spike.

A lesser starre there is also, which is yet notably marked, and called *Prouindemiator*. 7 Libra.

Prouerigetes,

After Virgo cõmeth Libra, the signe of Justice & equity: but it is the least signe in quantitie of al other in the zodiak, for it occupieth scarse halfe a signe in length: and no maruell, sith that cruell Scorpius doth inuade so great a portion, and presseth all that Signe out-right: yet hath it 8 stars, but not one out of the Scorpions claws.

Then Scorpius with his hooked taile, and with his clawes doth reache so farre, that two full signes hee taketh in length and 30. degrees almost in 8 Scorpius. breadth, yet hath he but 21 stars beside those which be in his clawes, and are common to them and to Libra: amongst all which the principal is that which is called the Scorpions heart, and is named of the Greekes *Antares*, and of Arbitians, *Calbalatrab*.

After him ensueth one of the Centaures like an archer on horsebacke, with many faire starres, though they be not of the greatest: hee hath in all 31. 9 Sagittarius. This signe is called Sagittarius in Latine, and in Greeke *Toxotes*. Capricorne then followeth with his monstrous shape, neither fish nor flesh, but mixed of both: a winterly signe and no waies pleasant, but that he giueth hope of the comfort of the Spring, because in it the sun beginneth to returne to vs againe. He hath in him 28 starres of meane quantitie. 10 Capricorn.

Aquarius so fast doth follow him at hand, that he reacheth almost as forwardly as Capricorne, within lesse then 8 degrees: this signe hath in him 22 starres peculiar to himselfe, although Proclus name 4 of them in his right arme, to be the Water-pot. But beside these 22 starres, there are other 19, which in their diuers and crooked position doe make a forme of a riuer, and are called the Water which Aquarie sheddeth. With these 19 starres Ptolomy doth accompt one more, which is a beautiful star of the brightest sorte, and is in the mouth of the South fish, so that it is common to them both. This starre is called of Arabitians *Fomahant*: so that in all, the reare reckoned in this signe 42 starres. 11 Aquarius. The Waters pot. The Water.

Last of the 12 signes commeth the Fishes, tied by the tailes with a common Line: the foremost Fish hath but 8 starres, and his line hath 10. The latter Fish hath 11 starres, and his line hath but 5. And where those two lines are knit togither, there is one starre more, which is called the Knotte, that is in Greeke named *Syndesmos*: so that all the Starres togither, of this signe, are 34. 12 Pisces. The Line.

Whether Proclus did mistake any thing in this sign, I wish other to iudge because I intended here not to intreate at large, and much lesse to scan other mens writings. And thus wil I end the 12. Signes of the zodiake.

1 The Whale.

Now to diuert vnto the South signes: first appeareth the great Whale, containing 22 starres, whereof three be most noted: the first in the nether chap, which is in Latine called *Mandibula ceti*, and in Arabike *Menkar*: the second is called the Whales belly, in Arabike *Baten kaitos*, & in Latine *Venter ceti*: the thirde is the Whales taile, named *Cauda ceti* in Latine, and in Arabike *Denebkaitos*.

2 Orion.

Next followeth Orion the stormy signe, and hath diuers starres, to the number of 38: but the most notable are 6. the first is in his right shoulder, and is called by the Arabitians *Bed Algeuz*: the second is in the left shoulder, and is named *Bellatrix*. other three stand as bullions set in his girdle, and are called of many English men the Golden yard. Then is there in his left foot a great starre of the brightest sort, which is named of the Arabitians *Algebar*, and *Rigel Algeuze*. Beside these sixe there are other starres more notabe for their forme then for their quantities, as the two starres which betoken his clubbe in his right hande, and 9 starres by his left hand, which represent a Lions skinne: and other three do limit his sword, lying crosse his backe vnder his girdle.

3 The Riuer.

Betweene Orion and the Whale is there a great tract of starres, which represent the forme of a riuer, and therefore are they called the Riuer: which some more peculiarly name *Eridanus*, and other *Nilus*. Proclus calleth it Orions riuer, because it beginneth at his left foote, and hath one starre common with his foot: but besides that it hath 34 starres, whereof the last is one of the greatest light.

4 The Hare.

By the beginning of this riuer, vnder the feet of Orion, is there a constellation of 12 starres, named the Hare. And after it towarde the East is the greater Dogge, (of whom the Canicular dayes beare name)

5 The great Dogge.

and is called of the Greeks *Sirius*, and of the Latines *Canis*, hauing 18 starres, but one especially in brightnesse more notable then any of the rest, and that is in his mouth, and is called peculiarly *Sirius* and *Canis*, by the name of the whole signe, and of the Arabians *Alhabor*.

6 The lesser Dogge.

North almost from this Dog is there a constellation of two onely starres named *Canicula*, the lesser Dogge, and in Greeke *Procyon*, the fore dogge, whom Tully therfore calleth *Antecanis*, and other name him *Præcanis*. At the taile of the greater Dog is the famous ship Argo, which comprehendeth 45 starres, whereof eight be beautifull, but one in especiall, which is in the foot of the ruther, and is called *Canopus*, and of the Arabitians *Suhel*. This starre is not seene in England, France, Germany nor Italy, and scarsly in the most Southerly partes of Spaine. And here by the way I will note a place in Proclus very much corrupted, which nowe I will onely correct as I thinke good: and another time will intreate more largely of it and of other moe: the wordes are these.

7 Argo the Ship.

Stella vero illa splendida quæ in imo Argus gubernaculo sitæ est, Canopus dicitur: ea in Rhodo vix conspicitur, aut certè ab editis locis. In Alexandria vero

vero prorsus ✶ conspicua est, vtpote ferè quarta signi portione supra Horizontem erecta.

Non cernitur. Transtulit Latinus interpres, Græci codicis errorem imitatus.

The bright starre in the foote of the ruther of *Argus* is called *Canopus*, which in the Rodes can scantly be seene, except it be from high places: but in Alexandria it may well be seen, for it doth rise there nigh a quarter of a signe aboue the horizont.

Scholler.

This is contrary to the common translation.

Maister.

And that common translation is as contrary to common sense, but thereof another time shall we talke, when I minde to teache you the exact order of ascension for al these constellations, and of their chiefe starres also. And now to proceed as we began. Next after this ship there followeth the great Serpent, which is called of the Greekes and Latines *Hydra*. It containeth 25. starres, and stretcheth in great length by the space of 3 whole signes. One star there is in it brighter then the rest, and that is named by the Arabians, Alphard.

8 The Serpent of the south.

On this *Hydre* there resteth other 2 small constellations, the one named the Cuppe, and the other the Rauen.

The Cuppe includeth seuen starres all of one bignesse. This Cup standeth on the Hydres backe, almost in the middle of him.

9 The Cuppe.

The Rauen standeth on the same Hydre, more neerer toward the point of his taile: and it is formed of 7 starres also, of which that which is in his wing, is called in Arabike, *Algorab*.

10 The Rauen.

Under the taile of this Hydre and those two other small constellations, there standeth the Centaure Chiron, like a light horseman with his chasing staffe: he hath in him 37 stars, wherof 4 be in ꝑ garnish or pensil of his speare, and them doth Proclus reckon as a peculiar constellation, and nameth it in Greeke *Thyrsolochus*. And Ptolomy doth reckon those stars naming them to be in that speare: wherfore I muse how Stoffler seemed so ignorant herein, to denie that Ptolomy doth make any mention of that speare, and himselfe deuiseth out of Ptolomy 6 wrong starres for that purpose: it appeareth he was deceiued by the old translation, where *Clypeus* is translated for *Hasta*: that is, shield for speare. Which wrong translation Schoner, Copernicus, and Erasmus Rheinhold do followe, and diuers other learned men, but against reason.

11 The Centaure. The Centaures speare.

Scholler.

I think it (as many things els be) is receiued by credite of authoritie, without disquisition of reason, which blindeth many witty men oftentimes.

Maister.

Yet is their fault the more pardonable, if they acknowledge their errour

12 The Wolfe.

whē they be friendly admonished: but this is beside our purpose at this time, therefore to return: This Centaure with his right hand doth hold a Wolfe, which is a seuerall constellation made of 19 starres, although Hyginus and others doe reckon fewer in him, as they doe vntruely in many other. Under that beast toward the South, hard vnder the Scorpions taile, standeth the

13 The Altar.

Altar, made of 7 Starres of the meanest light: but it is not seene in England aboue the horizont. By this Altar Eastward betweene the two former

14 The South Crowne.

feete of Sagittary, there is the Crowne of the South, formed of 13 small stars: Proclus and Theon doe call it also *Vraniscus*, as many later writers in their time did name it: but Theon doth farther affirme that it hath 19. stars: which must seeme to be an errour, rather in the booke then in the authour: wherein obseruation cannot helpe vs in England, sith it riseth not aboue our horizont, but only toucheth it.

15 The South Fish.

After it followeth the South fish, containing 12 starres: whereof one only is of the greatest light, and that is it which standeth also for the end of the water that runneth from Aquarius. This fish lieth betweene the constellations of Capricorne and Aquarie, so that it is partly vnder them both.

These be the Constellations most commonly noted amongst ancient writers: howbeit one more there is named to lie betweene the Lions taile and

16 Berenices haire.

Vrsa maior, which is called *Berenices* haire, some call it in Latine *Trica*, and other *Berenicis crines*. Conon that famous astronomer did first name it, and Callimachus did declare it, and therefore doth Proclus ascribe the first noting of them vnto Callimachus. The starres in it are 7, as Hyginus and Basilus doe accompt them: but they are very darke, and therefore Ptolomie doth number only three of them, as the bounds of that former. Beside these 50 constellations, there be a great number of starres, which be not assigned to any figure, but lie dispersedly about those other constellations, whereof 61 are in the north part of the skie, and annexed with the northerly signes: and other 19 in the south part of the zodiake: vnto which if you adde 337 which be in the north constellations, and 316 in the south constellations, with 292 in the zodiake; so haue you in al 1025 stars which be noted by Astronomers: but in Ptolomies accompt there appeare but 1022, because hee doth not accompt any star of *Berenices* haire, but called it the Traces of haire. These stars be not of one quantitie, but some much brighter then other; and therfore are they distinct into diuers measures of light, and namely 8, which are called the first greatnesse, the second, the third, the fourth, the fift & the sixt, vnder which they are that be called Cloudie starres: and a lesser sort yet named Darke starres: of all which, and the measure of their quantitie, I wil at another time speake more fully, for this place and time agreeth euill with the matter, and that much worse, then at the beginning it seemed to doe.

61
19
337.
316
292
1025

Scholler.

There

There remaine yet many titles vntouched of them which I gathered.

Maiſter.

And many of them ſmally agreeable for this treatiſe, but do more aptly appertaine to Coſmography, and therefore ought to be reſerued for that worke: ſaue that ſome of them are peculiar for the Theorike of Planets, and yet wil I lightly touch them in few wordes, for ſo much as may ſeeme to helpe to this treatiſe.

Scholler.

I remember at the beginning you promiſed to ſhew a cauſe why you name but 8 ſpheres, where as other men do accompt more: and alſo how it may appeare, that there are ſo many, for the eies can ſee but one only, which is the firmament. How the number of ſpheres is knowne.

Maiſter.

Your ſelfe ſaid, you had marked (as many mariners, yea and al men doe almoſt) that the moone doth euery day runne Eaſtward notably, ſo that in a weeke ſhe paſſeth a quarter of the ſkie in that courſe, and in 15 daies ſhe runneth halfe the compaſſe of the ſkie, and ſo in a moneth ſhee returneth to the ſun againe, hauing paſſed all the circuit of heauen. So of the Sun you haue vnderſtood that in a yeare he trauerſeth ouer al the length of the zodiake, contrary to the courſe of the firmament, whereby it muſt needes appeare vnto you, that ſeeing the ſun and the moone haue courſes diſtinct from the fixed ſtarres, they muſt needs haue diſtinct ſpheres alſo, wherein they doe mooue, and accompliſh their courſes. The Moone. The Sunne.

Scholler.

I remember I haue heard it often repeated as a principle in nature, that one ſimple body can haue but one ſimple motion. And therefore where diuers motions be, it muſt needes follow that there are diuers bodies as their workers, which you in this talke doe call ſpheres.

Maiſter.

As you may thinke that their ſpheres are diſtinct from the Firmament by reaſon of their ſeuerall motions, ſo are they diſtinct aſunder by the ſame reaſon.

Scholler.

It is moſt certaine.

Maiſter.

Then if by good obſeruation it haue been prooued, that there be 5 other ſtarres which haue their mottons all diſtinct from the ſtarrie ſkie, and eche of them from their fellowes, it will appeare reaſonable that euery one of them hath a ſeuerall ſphere peculiar for himſelfe, and for his priuate motion.

Scholler.

It will follow of neceſſitie.

Maister.

Then I wil begin with your selfe for one of them, which I am sure you cannot but marke, as al men, yea the very Plowmen doe. And that is Venus, which I dare say, you haue marked in the euening to set after the sunne, and then is she named the Euening Starre, and yet doth she not at al times shine like space after sun setting, but sometimes more and sometime lesse. And if you marke her well, then shall you perceiue, that the first night that she appeareth, she shineth lesse time then she doth the second night, and so increaseth the time of her shining for a space, and then doth she abate againe by little and little, till she ioyne with the sun, and then appeareth no more at euening, but shortly after wil she shew in the morning before the sun rising, & increase the time of her shining by little and little, till she come to the farthest of his distance from the sunne, and then will she abate againe in like manner, till shee come within the beames of the Sunne, and leese her appearing for a time.

Venus.

Scholler.

This is most certaine and knowne of al men vulgarly, although few men doe consider the cause thereof: but nowe I doe remember what you taught me of the ascensions poeticall (as they be named) and namely of that which you thought meeter to be called apparition, whose contrary you called Occultation: so that when Venus doth shine at euening after sun setting, shee doth rise as some tearme it, with a sunlike rising: and when she is hidden againe, she is set with a sunly setting: but that you iudge Appartition and Occultation more apter tearmes.

Maister.

You doe not gesse much amisse. And to the intent that you may consider this matter the better, I thinke it good that you doe marke her motion the more diligently hereafter: as in this present moneth of September, at the beginning of the moneth she was about 36 degrees behinde the sunne, and so should shee shine almost two houres and a halfe after the Sunne, as it might appeare by the degrees of distance. But considering the obliquitie of the zodiake, and the latitude of Venus at that time, she did scarse shine three quarters of an houre after the sunne.

Scholler.

This talke is too obscure for me yet.

Maister.

I know it right wel. But yet I thought good to admonish you in that matter, least at any time you should finde the doubt, when you shal haue no opportunitie to aske counsell therein: but nowe to proceede. Before the end of the same moneth of September, the saide Planet wil be cleane hidde with the Sunne beames: for within two dayes after (I meane the second day of October) she doth ioyne with the sunne by coniunction. And from that day forward

ward the ſunne doth outgo her ſo faſt, that by the thirteenth day of October ſhe will be out of his beames againe, and riſe almoſt an houre and a quarter before the ſunne. And at the end of Nouember, ſhe will be ſixe and fortie degrees behinde the ſunne, in order of the ſignes, and yet ſhall ſhee riſe foure houres and more before the ſunne, whereas the number of degrees are equall to little more then three houres: but the obliquitie of the horizont doth make all the diuerſitie in this, except a meane trifle by the latitude of Venus. And thus may you marke Venus in all that month, and in December alſo vnto the end of the yeare: but then doth ſhe abate her diſtance againe, whereby it is eaſie to vnderſtand, that ſhe hath a ſeuerall motion from the ſunne, and a ſeuerall ſphere alſo.

Scholler.

In Venus it appeareth now eaſie enough to conſider, as well as in the ſunne and moone: but is it as eaſie in the other foure planets?

Maiſter.

Yea indeede, for three of them which be moſt higheſt, if you liſt to learne to know them, and to marke their courſes: but Mercury is not ſo well marked, becauſe he doeth alwayes keepe his courſe nigh about the ſunne, and therefore his obſeruation requireth great diligence, and his courſes appeare moſt ſtrange, yet both hee and Venus do accompliſh their courſe in a yeare with the ſunne: but Saturne is ſo ſlacke a mouer, that you ſhall not well perceiue his motion vnder foure moneths: in which time he doth mooue about foure degrees: ſo that if you marke his place at any time, and within foure moneths after that time if you doe marke him againe, you ſhal perceiue that he is gone foure degrees eaſtward, which you may marke by the fixed ſtarres about that place: but if you do after a whole yeare marke his place, then ſhall you perceiue well and manifeſtly, that he is gone eaſtward twelue degrees, and ſomewhat more: as for example. The firſt day of September, the laſt yeare 1555, Saturne was in the twelfth degree of Aries, & this yeare of 1556 we ſee him to be in the 26. degree of the ſame ſigne, whereby it doeth appeare that hee hath mooued foureteene degrees eaſtward in that yeare ſpace. And if you will haue further proofe: In the yeare of our Lorde 1549. the laſt day of Nouember, Saturne was ſeene in the 26. degree of Capricorne, and this yeare of 1556. the firſt of September, the ſame ſtarre was in the 26 degree of Aries: whereby it may be knowen that he hath moued three whole ſignes (which is a quarter of the zodiake) in ſeuen yeares ſpace. And ſo in leſſe then 30. yeares he goeth about the whole zodiake. Mercury. Saturne.

Iupiter hath a ſwifter courſe, for he paſſeth the circuite of heauen in leſſe then 12 yeares: ſo doth he euery yeare runne ouer one ſigne, and euery two moneths he paſſeth 5 degrees. Iupiter.

Mars is yet ſwifter in courſe then hee, and compaſſeth all the Zodiake Mars.

in

in twe yeres, and euery month passeth halfe a signe: whereby for this point, he is more easie to be marked, than any of the other: but yet are his motions difficult to marke in other points: but this may suffice for triall that he moueth eastward, as all the other planets do: and therefore must he be iudged, as all the other also ought to haue seuerall spheres in which they moue. And although their spheres cannot be seene, yet inasmuch as their starres may be so well perceiued, it must needs follow, that they haue spheres also, except we should come to that absurditie to say, that they moone in the ayre as birds do, or as fishes in the water: which were too much repugnant to any one orderly motion, and much more disagreeing to so many diuers motions as are in the planets, but namely in Mars and Mercury. And to the intent that you may know them the better, it shal be good that you learne their true places by the Ephemerides, and accustome your selfe to looke for them, and to marke their bignesse and colours how they differ from other starres: which is spoken by way of exhortation onely, and not proponed as any peece of this Booke: but an other time I wil instruct you better therein.

Scholler.

But in the meane time, how shall I knowe whether there be any more spheres or no?

Maister.

Of the ninth and tenth sphere.

There is thought to be in the eight sphere or firmament, two other motions, which be disagreeable from all other moouings before mentioned, and therfore, thinke, that they must of necessitie confesse two other spheres many from which those motions must proceede peculiarly.

Scholler.

What motions are those, and how are they knowen?

Maister.

First, there is one notable obseruation by conference of learned men in diuers ages, concerning the equinoctiall points, and likewise concerning those tropicall points that the sunne toucheth twice euery yeare: for about the incarnation of Christ, the Equinoctiall point or instant happened about the 25 day of March, and now it is about the tenth of the same moneth, which disagreement doth rise partly by the misorder in the Leape yeares, but most principally through the anticipation of the Equinoctiall termes. For although the sunne doe at the yeares end returne to the same point in the starry skie where he was at the beginning of the same yeare, yet is he not exactly so nigh vnto the Equinoctiall point as he was before, but doeth ouer-runne it euery yeare, and thereby in continuaunce of time it commeth to passe, that men may sensibly perceiue that the starres are runne eastward from that equinoctiall point.

Scholler.

This

This ſeemeth ſomething obſcure, except you can declare it more plainly.

Maiſter.

Doe you not conſider betweene the ſunne and the moone, that when ſhee doth ioyne with him by coniunction, and then ouerpaſſeth him by her ſwift motion, that when ſhe returneth againe to the ſame place where ſhe did leaue the ſunne, ſhe doth not finde him there, but ſhe muſt ouergo that place, before ſhe can ouertake the ſun againe, by reaſon that the ſun did mooue forward after the moone in the ſame courſe, though much more ſlowly: So likewiſe, when the ſunne departeth from any ſtarre in the ſkie, in the very inſtant of the equinoctial equalitie, and in the very point of the interſection of the Equinoctial and the Ecliptike line, where of neceſſitie that equalitie muſt happen: if the ſunne returning after a yeare vnto that equinoctial point, doe not finde the ſtarre there preciſely, which he left there, but that hee muſt ouerrun that point before he can come againe to the ſaid ſtarre, may not we, yea and muſt not we ſay, that that ſtarre is mooued forward in his courſe eaſtward, as all the Planets doe mooue? Howbeit the quantitie is ſo little, that it is not perceiued by ſight alone, neither yet by inſtrumentes, in leſſe then an hundreth yeares, ſo that no one man is able to marke any great diuerſitie in his owne age, but muſt be faine to conferre with other men that haue made obſeruations long before, and written them: ſo did Ptolomy conferre his obſeruations with Hipparchus obſeruations, and founde that from Hipparchus time vnto his owne age, the Fixed ſtars were mooued forward from the Equinoctial point, two degrees, and fortie minutes: Whereby hee did coniecture, that they mooued euerie hundreth yeare one degree, ſith the time betweene their two obſeruations was 265. yeare: and after the like rate was the ſame motion found by conference of the obſeruations of Timochares and Hipparchus. What other men ſay for more preciſeneſſe herein ſith their time, I will in the Theorikes declare vnto you: but all agree herein, that the ſtarres doe mooue vniformely with all their ſphere eaſtward, as the Planetes doe. Wherefore many aſſigne that motion as peculiar to the eight ſphere, and the daily motion from Eaſt to Weſt they appoint to the ninth ſphere. Other men perceiuing that the ſtarres doe alſo aſcend northward, and deſcend againe Southward, do aſſigne a certaine motion, which is named by them *Motus trepidationis*, and they note it to be peculiar for the eight ſphere, and the other motion laſt named before, they accompt to be proper to the ninth ſphere: then of neceſſitie it followeth, that a tenth ſphere (as they ſay) muſt be aſſigned for the dayly motion.

Scholler.

If it be true that there be ſuch varieties of motions, then it ſeemeth reaſonable to aſſigne ſo many ſpheres as there be motions ſeuerall.

Maiſter.

Although you thinke so now, you may be perswaded peraduenture to think the contrary hereafter, as most wise men in that arte do.

Scholler.

But in the meane season what shall I thinke?

Maister.

Thinke well on that that you haue learned, and labour to be expert in all that, by often conference of your learning, with the practise of the globe, and so shall you be apt to bee instructed in all the rest the more easily: for it will require a wit somewhat ready, and practised in these former matters.

Scholler.

I will then prepare me a sphere (without which I see I can do litle good herein) and so will I practise these former lessons, that I trust to be as ready in them, as any auditour in framing of account.

Maister.

By that meanes shal all other things in this arte appeare easie vnto you, which now might seeme vntimely put forth, if I should offer to teach them, as the motions of the Sunne, Moone, and other Planets, with their eccentrikes, equants, deferents and epicycles.

Scholler.

Indeed I thinke this too hard yet, but of the progression, retrogradation, and station of the Planets, and also of the eclipses of the Sunne & Moone, I know that Iohn *de sacro bosco* did write somewhat, and so might you briefly now do.

Maister.

His wordes are short, and therefore obscure, and so should my wordes be: beside that, it is a disorderly forme to put the cart before the horse: I meane to write of the passions of the Planets, before I haue sufficiently taught the full order of their motion. Therefore I will say in few wordes, that the reasons of the passions cannot be taught aptly, before the theorikes of their motions. But for contentation of your mind, I may define after a sort the eclipses of both the sunne and moone: whereof the first is but an appearant and a counterfeit eclipse, and is no want or losse of the light in the Sunne it selfe, but is an impediment, that his light doeth not or can not extende vnto vs, by reason that the Moone doth run betweene him and our sight. And this eclipse as it hideth the Sunne from vs for a time, so in some partes of the earth at the selfe same instant hee is not any whit eclipsed, but shineth cleerely and wholly: and therefore is that eclipse called no generall eclipse, which should extende to all the worlde, namely for that hemisphere, but is particular for some one climate, and yet not vniuersall to all that climate: but contrariwise the eclipse of the Moone is a true eclipse indeed: for there is nothing that runneth betweene our sight and her, & so hideth from vs her light, but she looseth her light certainly. As if a glasse that standeth in the sun, do receiue the light

The eclipse of the Sunne.

The eclipse of the Moone.

of

of the ſun, and doe caſt beames (as we may ſee) from him, till ſome cloud or ſome other dark body paſſe betweene the ſunne and it, and then it leeſeth his light cleerly, & hath no light but his own brightnes, which can caſt no beams, neither deſerue any name of light, in compariſon to the light that it had of the ſun: So the moone keeping her courſe til ſhe be at the full, that is to ſay, in the contrary point of the zodiake to the ſun, and that then ſhee be without all latitude, and run right vnder the Ecliptike line in the zodiake; then doth ſhee light directly in the ſhadow of the earth, and therefore cannot receiue the light of the ſun, but leeſeth it for the time: howbeit not alwaies alike, for ſometime ſhe commeth wholly within the ſhadowe of the earth, and then is ſhe wholly eclipſed: at other times ſhe commeth but partly into the ſhadow, & that ſometimes in the ouer part, and ſomtimes in the nether part, wherby ſhe is eclipſed partly, and not vniuerſally: for if the moone paſſe by the north or ouerpart of the ſhadow, and touch it with any part of her ſelf, then is that part eclipſed of neceſſitie, which is the ſouth part of the moone or the nether part of her. And again, if the moone do touch the nether part of the ſhadow which is next to the horizont, then is the higher or northerly part of the moon eclipſed. To tel you now of the ecliptical pointes, which be commonly called the Head and the Tayle of the Dragon, it were very vntimely, and hard for you briefly to conceiue, and therefore I doe willingly omit them.

Scholler.

Yet this I perceiue by you, that the ſun is not darkened in himſelfe, but is hid by the moone from vs, which happeneth diuerſly: for ſometime all the ſun is hid, and ſomtime the higher part only, & at other times, the nether part only: of al which formes, I may ſee examples in euery common Almanack after a groſſe ſorte: but this figure doth more aptly expreſſe ỹ cauſe thereof, where the Moone doth appeare to be betweene any one Region & the ſun, & therfore hideth the ſun from the inhabitãts of that place: but in other Regions there appeareth no ſuch let of the Moone, but that they may fully ſee the ſun, and other Nations betweene them, ſee part, and leeſe other part.

And this I perceiue may be conſidered diuerſly, inaſmuch as any be nigher to them that ſee the whole ſunne, or nigher to thoſe that ſee his Eclipſe.

Maiſter.

There is in that nighneſſe double conſideration: one is of diſtance between Eaſt and Weſt, and that other is of diſtance between ſouth and north. For when any nation doth perceiue the higher cantle of the ſun eclipſed; then they that dwell more northerly, (vnder the ſame meridian) doe leeſe more of the ſunne, and iudge that eclipſe the greater: and contrariwiſe they that dwell directly toward the South, the farther ſouth they dwell, the leſſer doth the part eclipſed appeare to thē to be, till at length vnto them that dwell more ſouth there appeareth no eclipſe at al. The ſecond conſideration betwixt Eaſt and Weſt, doth cauſe only diuerſitie in time of the Eclipſe, but not in forme: and that is common alſo for the eclipſe of the Moone, but ſo is not the firſt conſideration, but ſerueth for the ſuns eclipſe only.

Scholler.

As for the eclipſe of the Moone, I thinke the former figures which you did ſhew me, doe comprehend all varieties of formes ſufficiently, which be theſe two, for the other two do repreſent thoſe falſe formes that doe follow of certaine falſe figures of the earth: and therefore do not ſerue heere in place of true doctrine.

Maiſter.

This may you now alſo conſider, that although the eclipſe of the ſunne is not

not general to al nations, becauſe it is not a true eclipſe or want of light, but onely an appearant Eclipſe: yet the eclipſe of the Moone is a very Eclipſe indeede, that is to ſay, a want of light in her ſelfe, and therfore whoſoeuer doth ſee her, doth ſee alſo her eclipſe exactly as it is: and it appeareth vniformly to them all, though at that time the moone be not nor cannot be aboue the horizont to al people: and therefore vnto them that haue the moone vnder their horizont, it is accompted none eclipſe. And that is the cauſe why many eclipſes of the ſunne and moone alſo are not noted in the common Ephemerides and Almanackes, becauſe they appeare in ſuch time as the Planet eclipſed is vnder the horizont of that Region for which the Almanacke or Ephemerides is written. Furthermore, this is to be conſidered as a very trueth and moſt infallible, that the eclipſe of the ſun can neuer happen but at the very change of the moon, for at other times ſhe is ſo farre in order of her courſe from the ſun, that ſhe cannot hide any part of him from any nation in earth. And for the eclipſe of the moone, the time of oppoſition or full moone doth ſerue only: For the ſhadow of the earth which alway runneth toward the Nadir of the ſun directly, cannot touch the moon except ſhe be very nigh vnto the ſame place. And that is the cauſe why the Eclipſe of the ſunne which happened at the death of Chriſt, may not bee accompted a natural eclipſe, forſomuch as it happened in the time of the full moone, when it is not poſſible by natures order, that any ſuch eclipſe ſhoulde happen. And therefore did Dyoniſe the Areopagite being in Alexandria, and Apollophanes his companion, not only wonder at this ſtrange and vnnaturall eclipſe, but concluded, that it could not happen without ſome marueilous cauſe, and a wonderful immutation of natures workes.

Scholler.

So doth our Author of the ſphere note it, affirming that Dionyſe did ſay then: Either doth the God of nature ſuffer now, or elſe the whole frame of the world ſhall now be diſſolued.

Maiſter.

With this good clauſe did he end his booke, and ſo will we with the ſame end cloſe vp our talke: Learning this good vſe in this naturall Arte, that it leadeth men wonderfully to the knowledge of God, and his high myſteries: as not onely by example of theſe two Philoſophers here it doth appeare, but by the teſtimonies of the ſcriptures in ſundry places.

Scholler.

This was that Dionyſe whom S. Paul conuerted afterwards at Athens. And the rather much becauſe he had in remembrance that miraculous Eclipſe.

Maiſter.

So

So may we gather many arguments by like matters against infidels and false christians also: but that fruit will I reserue for an other place: and for this present will onely say, that there was neuer any good Astronomer, that denied the maiestie and prouidence of God, though many other denied both: but now farewell for a time: I am driuen to omit teaching of Astronomie, and must of force go learne some lawe.

Scholler.

The God that is authour of true Astronomie, and made all the heauens for men to behold, keepe you in health, and cleare from all trouble, that you may, as you minde, accomplish your workes, and finish well and speedily the fruites of your study.

Maister.

Amen, and Amen.

The Titles of the fourth Treatise.

1 What occasions mooued men first to iudge the forme of the worlde to be round, and namely three principall reasons thereof.

2 That the heauens are round in forme contrary to the error of Lactantius Firmianus, which thought it to be flat: and his opinion confuted by diuers reasons, namely by the view of the starres, by aptnesse of mooning, by reason of capacitie, and auoyding of emptinesse.

3 That the firmament doth moue, though Lactantius thought the contrary: and how it may be prooued, especially by the milkie way. And that the starres doe not moue as birdes in the aire, or as fishes in the water.

4 That the heauens are not cornered, neither of many angles.

5 That all things shew greater then they be, through vapours, and therfore the starres with the sunne and moone do appeare greatest nigh vnto the horizont.

6 Diuers opinions of the forme of the earth: some thinking it to be of cubike forme, other iudging it to be ridge formed, other affirming it to be plaine, other deeming it hollow as a dish, and other esteeming it long and round, like a piller or roller: all which being sufficiently confuted, it is fully prooued, that the earth is iustly round in shape.

7 Then follow diuers reasons, approoning the water to be round, and a declaration with proofe why the water doth not, neither cannot ouerrunne the whole face of the earth.

8 That

8 That the earth and water togither do make but one round globe, and haue therefore one common centre.

9 That the earth is but as a prick in comparison to the ſkie, which is approoued by foure diuers argumentes.

10 The diſtance of euerie ſphere from the centre of the earth, with an order to try the quantities of the ſunne and moone, &c. in comparison to the earth.

11 That the earth is in the middle of the world, and the contrary opinions repeated and confuted by ſundry proofes.

12 That the earth doth not mooue from the centre of the world.

13 A briefe rehearſall of the paralelle circles, with an inſtruction howe to finde the diſtance of the Tropikes, and the greateſt declination of the ſunne, and of euery degree of the zodiake from the equinoctial circle.

14 That the Arctike and Antarctike circles are not permanent, but mutable, according to the chaunge of the Regions, and ſo their quantities varieth, and their diſtance altereth, in reſpect to the other paralels: and their order chaungeth diuerſly.

15 The zones being immutable, ought not to be diſtinct by the Arctike and Antarctike circles which are mutable, but rather by the Polare circles which perſeuer ſtill, and keepe their quantities, their diſtance and their order vniformly.

16 That there are no zones vninhabitable either for heate or cold, but may be and are alſo inhabited, as it is well knowne.

17 The Zodiake is named of the twelue ſignes, which ſignes are taken in diuers ſignifications. And how any ſtarre or Planet is named to be in any ſigne. Alſo what is the longitude, latitude and declination of any ſtarres or Planetes.

18 The Colures, what they be, and how many in number, and whereof they take their name.

19 The horizont celeſtiall and terreſtrial, how they be diſtinct: where Proclus ſentence is reprehended, and three ſeuerall tables ſet forth for diſtinction of houres, according to diſtance of miles from Eaſt to Weſt, and that for diuers climates.

20 The order and number of the Climates, with the eleuation of the Pole and the quantities of the longeſt day in eche of them.

21 Of aſcention Aſtronomicall and Poeticall, and how euery one of them is diſtinct: With certaine rules of aſcenſion Aſtronomicall, and tables for the ſame, both in the Right ſphere, and alſo in diuers Oblique ſpheres.

...mination of the rules of *Iohn de ſacro boſco*.

22 The diſtinction of houres into houres equall, and houres vnequall: and that houres vnequall be conſidered in two diuers ſortes, with tables ſet foorth for ech ſort, concerning their quantities.

23 Of dayes Artificiall and Naturall: and what are the cauſes of diuerſitie in ech of them, with tables for the quantities of the ſame: and a declaration of the ſunne riſing and ſetting.

24 The names of the conſtellations, with the number of their ſtarres.

25 A briefe declaration of the motions of the Planets, and conſequently, a reaſonable proofe for the number of their ſpheres. And further what occaſion there was, that men ſhould imagine the ninth and tenth ſphere to be, whereas there can none be ſeene aboue the eight ſphere.

26 A ſhort explication of the eclipſes of the ſunne and the moone.

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